5.2 AIM EXPRESS short listing

This clause specifies the EXPRESS schema that uses elements from the integrated resources and contains the types, entity specializations, rules, and functions that are specific to this part of ISO 10303. This clause also specifies modifications to the text for constructs that are imported from the integrated resources. The definitions and EXPRESS provided in the integrated resources for constructs used in the AIM may include select list items and subtypes that are not imported into the AIM. Requirements stated in the integrated resources that refer to such items and subtypes apply exclusively to those items which are imported into the AIM.

EXPRESS specification:

```
*)
SCHEMA plant_spatial_configuration;

USE FROM action_schema
  (action_directive,
   action_method_relationship,
   action_relationship,
   action_request_solution,
   action_request_status,
   action_status,
   directed_action,
   versioned_action_request); -- ISO 10303-41

USE FROM application_context_schema
  (application_context,
   application_protocol_definition,
   product_context,
   product_definition_context); -- ISO 10303-41

USE FROM approval_schema
  (approval,
   approval_date_time,
   approval_person_organization); -- ISO 10303-41

USE FROM basic_attribute_schema
  (description_attribute,
   id_attribute,
   name_attribute,
   role_association); -- ISO 10303-41

USE FROM date_time_schema
  (calendar_date,
   date_and_time); -- ISO 10303-41

USE FROM document_schema
  (document,
   document_relationship,
   document_usage_constraint); -- ISO 10303-41

USE FROM external_reference_schema
  (external_source,
   externally_defined_item,
   externally_defined_item_relationship,
   pre_defined_item); -- ISO 10303-41

USE FROM geometric_model_schema
  (block,
   boolean_operator,
   boolean_operand,
   boolean_result,
   brep_with_voids,
   csg_solid,
   cyclide_segment_solid,
   eccentric_cone,
   ellipsoid,
```

```
    extruded_area_solid,
    extruded_face_solid,
    faceted_brep,
    geometric_curve_set,
    geometric_set,
    geometric_set_replica,
    manifold_solid_brep,
    rectangular_pyramid,
    revolved_area_solid,
    revolved_face_solid,
    right_angular_wedge,
    right_circular_cone,
    right_circular_cylinder,
    shell_based_wireframe_model,
    solid_model,
    sphere,
    swept_face_solid,
    swept_area_solid,
    torus); -- ISO 10303-42

USE FROM geometry_schema
  (axis2_placement_2d,
    axis2_placement_3d,
    b_spline_curve,
    b_spline_curve_with_knots,
    b_spline_surface,
    b_spline_surface_with_knots,
    bezier_curve,
    bezier_surface,
    boundary_curve,
    bounded_pcurve,
    bounded_surface_curve,
    cartesian_point,
    circle,
    composite_curve,
    composite_curve_on_surface,
    composite_curve_segment,
    conical_surface,
    curve_bounded_surface,
    curve_replica,
    cylindrical_surface,
    degenerate_pcurve,
    degenerate_toroidal_surface,
    direction,
    ellipse,
    evaluated_degenerate_pcurve,
    geometric_representation_context,
    geometric_representation_item,
    hyperbola,
    intersection_curve,
    line,
    offset_curve_2d,
    offset_curve_3d,
    offset_surface,
    outer_boundary_curve,
    parabola,
    pcurve,
    plane,
    point,
    point_on_curve,
    point_on_surface,
    point_replica,
    polyline,
    quasi_uniform_curve,
    quasi_uniform_surface,
    rational_b_spline_curve,
    rational_b_spline_surface,
    reparametrised_composite_curve_segment,
    rectangular_composite_surface,
    rectangular_trimmed_surface,
```

```
   seam_curve,
   spherical_surface,
   surface_curve,
   surface_of_linear_extrusion,
   surface_of_revolution,
   surface_patch,
   surface_replica,
   toroidal_surface,
   trimmed_curve,
   uniform_curve,
   uniform_surface); -- ISO 10303-42

USE FROM group_schema
  (group,
   group_relationship); -- ISO 10303-41

USE FROM management_resources_schema
  (action_assignment,
   action_request_assignment,
   approval_assignment,
   classification_assignment,
   date_and_time_assignment,
   date_assignment,
   document_reference,
   group_assignment,
   identification_assignment,
   name_assignment,
   organization_assignment,
   person_and_organization_assignment,
   person_assignment); -- ISO 10303-41

USE FROM material_property_definition_schema
  (characterized_material_property,
   material_designation,
   material_designation_characterization,
   material_property,
   product_material_composition_relationship,
   property_definition_relationship); -- ISO 10303-45

USE FROM material_property_representation_schema
  (material_property_representation); -- ISO 10303-45

USE FROM measure_schema
  (amount_of_substance_measure,
   amount_of_substance_measure_with_unit,
   amount_of_substance_unit,
   area_measure,
   context_dependent_measure,
   context_dependent_unit,
   conversion_based_unit,
   count_measure,
   derived_unit,
   electric_current_measure,
   electric_current_measure_with_unit,
   electric_current_unit,
   global_unit_assigned_context,
   length_measure,
   length_measure_with_unit,
   length_unit,
   luminous_intensity_measure,
   luminous_intensity_measure_with_unit,
   luminous_intensity_unit,
   mass_measure,
   mass_measure_with_unit,
   mass_unit,
   named_unit,
   numeric_measure,
   parameter_value,
   plane_angle_measure_with_unit,
   plane_angle_unit,
```

```
    positive_length_measure,
    positive_plane_angle_measure,
    positive_ratio_measure,
    ratio_measure,
    ratio_measure_with_unit,
    ratio_unit,
    si_unit,
    solid_angle_measure,
    solid_angle_measure_with_unit,
    solid_angle_unit,
    thermodynamic_temperature_measure,
    thermodynamic_temperature_measure_with_unit,
    thermodynamic_temperature_unit,
    time_measure,
    time_measure_with_unit,
    time_unit,
    volume_measure); -- ISO 10303-41

USE FROM qualified_measure_schema
  (descriptive_representation_item,
    measure_representation_item,
    qualified_representation_item,
    precision_qualifier,
    type_qualifier); -- ISO 10303-45

USE FROM person_organization_schema
  (organization,
    organizational_project); -- ISO 10303-41

USE FROM presentation_organization_schema
  (presentation_layer_assignment); -- ISO 10303-46

USE FROM presentation_resource_schema
  (colour,
    colour_rgb); -- ISO 10303-46

USE FROM product_definition_schema
  (product,
    product_definition,
    product_definition_formation,
    product_definition_formation_relationship,
    product_definition_formation_with_specified_source,
    product_definition_relationship,
    product_definition_substitute,
    product_definition_with_associated_documents); -- ISO 10303-41

USE FROM product_property_definition_schema
  (characterized_object,
    product_definition_shape,
    property_definition,
    shape_aspect,
    shape_aspect_relationship); -- ISO 10303-41

USE FROM product_property_representation_schema
  (item_identified_representation_usage,
    property_definition_representation,
    shape_definition_representation,
    shape_representation); -- ISO 10303-41

USE FROM product_structure_schema
  (assembly_component_usage,
    make_from_usage_option,
    product_definition_usage); -- ISO 10303-44

USE FROM representation_schema
  (mapped_item,
    parametric_representation_context,
    representation,
    representation_context,
    representation_item,
```

```
   representation_item_relationship,
   global_uncertainty_assigned_context); -- ISO 10303-43

USE FROM shape_aspect_definition_schema
  (centre_of_symmetry,
   derived_shape_aspect,
   symmetric_shape_aspect); -- ISO 10303-41

USE FROM shape_dimension_schema
  (angular_location,
   dimensional_characteristic_representation,
   dimensional_location,
   dimensional_size,
   shape_dimension_representation); -- ISO 10303-47

USE FROM topology_schema
  (connected_face_set,
   edge,
   edge_curve,
   edge_loop,
   face,
   face_bound,
   face_outer_bound,
   face_surface,
   loop,
   oriented_closed_shell,
   oriented_edge,
   oriented_open_shell,
   path,
   poly_loop,
   topological_representation_item,
   vertex_shell,
   wire_shell); -- ISO 10303-42
(*
```

NOTE The schemas referenced above can be found in the following parts of ISO 10303:

action_schema	ISO 10303-41
application_context_schema	ISO 10303-41
approval_schema	ISO 10303-41
date_time_schema	ISO 10303-41
document_schema	ISO 10303-41
external_reference_schema	ISO 10303-41
geometric_model_schema	ISO 10303-42
geometry_schema	ISO 10303-42
group_schema	ISO 10303-41
management_resources_schema	ISO 10303-41
material_property_definition_schema	ISO 10303-45
measure_schema	ISO 10303-41
person_organization_schema	ISO 10303-41

presentation_organization_schema	ISO 10303-46
presentation_resource_schema	ISO 10303-46
product_definition_schema	ISO 10303-41
product_property_definition_schema	ISO 10303-41
product_property_representation_schema	ISO 10303-41
product_structure_schema	ISO 10303-44
qualified_measure_schema	ISO 10303-45
representation_schema	ISO 10303-43
shape_aspect_definition_schema	ISO 10303-47
shape_dimension_schema	ISO 10303-47
topology_schema	ISO 10303-42

5.2.1 Fundamental concepts and assumptions

5.2.1.1 property_definition, representation and representation_item

For a given item, non-shape properties are handled through a combination of **property_definition**, **representation**, and **representation_item**. All non-shape properties are grouped together and evaluated by a function for consistency. The **property_definition** serves as an aggregator of property values for a particular object. The **representation** collects individual elements of representation, usually in the form of name, value pairs that are applicable to a particular **property_definition**. The **representation_item** specifies a specific characteristic and its value. Shape properties are dealt with as a subtype and evaluated separately using **shape_definition**.

5.2.1.2 identifiers and types

Any identifier is used to differentiate between instances of an entity with respect to a scope of use or implementation of the identifier. If used in data exchange, the value of the identifier shall be unique within the exchange file and, additionally, may be unique between the partners in the exchange.

EXAMPLE 1 **Representation_context.context_identifier** may be any user-defined identifier that is used to differentiate contexts. REPCXT1, for example, may identify a **representation_context**.

Any type is used to specify the intent of the instance.

EXAMPLE 2 **Representation_context.context_type** may be ‘parametric’ if the geometry of a part is represented parametrically.

5.2.1.3 units

Units for a particular dimension specified in this part of ISO 10303 must be either globally specified or individually specified for each dimensional value. Different kinds of dimensions (e.g., length versus

weight), however, may be either specified globally or locally.

5.2.1.4 connector and connection

Connectors are **shape_aspect**s of the plant items that they belong to because they cannot exist independently. Connections are, therefore, a **shape_aspect_relationship**. Connections are also a **shape_-aspect** of the assembly that contains the connection, so connections are also **shape_aspect**s.

5.2.2 Plant spatial configuration type definitions

5.2.2.1 approval_item

An **approval_item** identifies a **change_action**, **piping_system**, or **versioned_action_request** that is assigned an approval status.

EXPRESS specification:

```
*)
TYPE approval_item = SELECT
  (change_action,
   piping_system,
   versioned_action_request);
END_TYPE;
(*
```

5.2.2.2 change_item

A **change_item** identifies the **assembly_component_usage**, **axis_placement_2d**, **axis_placement_3d**, **document**, **ducting_system**, **electrical_system**, **externally_defined_plant_item_definition**, **instrumentation_and_control_system**, **line_branch_connection**, **line_plant_item_branch_-connection**, **line_plant_item_connection**, **line_termination_connection**, **piping_system, plant**, **plant_item_connection**, **plant_item_connector**, **plant_line_definition**, **plant_line_segment_-definition**, **plant_line_segment_termination**, **process_capability**, **product**, **product_definition**, **product_definition_relationship**, **product_definition_shape**, **property_definition**, **reference_-geometry**, **site**, **site_feature**, **sited_plant**, or **structural_system** that can be modified, for which there is a request to modify, or that is the result of a change.

EXPRESS specification:

```
*)
TYPE change_item = SELECT
  (assembly_component_usage,
   axis2_placement_2d,
   axis2_placement_3d,
   document,
   ducting_system,
   electrical_system,
   externally_defined_plant_item_definition,
   instrumentation_and_control_system,
   line_branch_connection,
   line_plant_item_branch_connection,
   line_plant_item_connection,
   line_termination_connection,
   piping_system,
   plant,
   plant_item_connection,
   plant_item_connector,
      plant_line_definition,
```

```
   plant_line_segment_definition,
   plant_line_segment_termination,
   process_capability,
   product,
   product_definition,
   product_definition_relationship,
   product_definition_shape,
   property_definition,
   reference_geometry,
   site,
   site_feature,
   sited_plant,
   structural_system);
END_TYPE;
(*
```

5.2.2.3 change_life_cycle_item

A **change_life_cycle_item** identifies the **directed_action** that is classified.

EXPRESS specification:

```
*)
TYPE change_life_cycle_item = SELECT
   (directed_action);
END_TYPE;
(*
```

5.2.2.4 classification_item

A **classification_item** identifies the **cableway_system**, **ducting_system**, **electrical_system**, hvac_-component_definition, **hvac_connector**, **instrumentation_and_control_system**, **piping_component_-definition**, **piping_system**, **plant_item_connection**, **plant_item_connector**, **applied_document_-reference**, **product**, **product_definition**, or **structural_system** that is classified.

EXPRESS specification:

```
*)
TYPE classification_item = SELECT
   (cableway_system,
    ducting_system,
    electrical_system,
    hvac_component_definition,
    hvac_connector,
    instrumentation_and_control_system,
    piping_component_definition,
    piping_system,
    plant_item_connection,
    plant_item_connector,
    applied_document_reference,
    product,
    product_definition,
    structural_system);
END_TYPE;
(*
```

5.2.2.5 design_project_item

A **design_project_item** identifies the **product_definition** that is assigned to a **design_project**.

EXPRESS specification:

```
*)
TYPE design_project_item = SELECT
  (product_definition);
END_TYPE;
(*
```

5.2.2.6 action_request_item

An **action_request_item** identifies the **product** that is assigned to an **action_request**, indicating a request for purchase.

EXPRESS specification:

```
*)
TYPE action_request_item = SELECT
  (product);
END_TYPE;
(*
```

5.2.2.7 date_and_time_item

A **date_and_time_item** identifies the **product** that a **date_and_time** is assigned to.

EXPRESS specification:

```
*)
TYPE date_and_time_item = SELECT
  (change_action,
   change_item,
   change_life_cycle_stage_assignment,
   product);
END_TYPE;
(*
```

5.2.2.8 dated_item

A **dated_item** identifies the **action_directive**, **change_action**, **change_item**, or **product** that a date is assigned to.

EXPRESS specification:

```
*)
TYPE dated_item = SELECT
  (action_directive,
   change_action,
   change_item,
   product);
END_TYPE;
(*
```

5.2.2.9 document_item

A **document_item** identifies the **externally_defined_plant_item_definition**, **heat_tracing_-representation**, **material_property**, **piping_component_class**, **piping_system**, **plant_item_connector**, **plant_line_segment_definition**, **product**, **product_definition**, **product_definition_relationship**,

property_definition, **representation**, **representation_item**, or **site** that is associated with a **document**.

EXPRESS specification:

```
*)
TYPE document_item = SELECT
  (externally_defined_plant_item_definition,
   heat_tracing_representation,
   material_property,
   piping_component_class,
   piping_system,
   plant_item_connector,
   plant_line_segment_definition,
   product,
   product_definition,
   product_definition_relationship,
   property_definition,
   representation,
   representation_item,
   site);
END_TYPE;
(*
```

5.2.2.10 identified_item

An **identified_item** identifies the **document**, **material_property**, **product_definition**, or **shape_aspect** to which an identifier is assigned.

EXPRESS specification:

```
*)
TYPE identified_item = SELECT
  (document,
   material_property,
   product_definition,
   shape_aspect);
END_TYPE;
(*
```

5.2.2.11 plant_spatial_configuration_organization_item

A **plant_spatial_configuration_organization_item** identifies the **catalogue**, **change_action**, **design_-project**, **document**, **plant**, **product_definition_formation**, **product_definition_relationship**, or **site** that is associated with an **organization**.

EXPRESS specification:

```
*)
TYPE plant_spatial_configuration_organization_item = SELECT
  (catalogue,
   change_action,
   design_project,
   document,
   plant,
   product_definition_formation,
   product_definition_relationship,
   representation,
   site);
END_TYPE;
(*
```

5.2.2.12 plant_spatial_configuration_person_item

A **plant_spatial_configuration_person_item** identifies the **document**, **plant**, **product_definition_-relationship**, or **site** that is associated with a **person**.

EXPRESS specification:

```
*)
TYPE plant_spatial_configuration_person_item = SELECT
  (document,
   plant,
   product_definition_relationship,
   representation,
   site);
END_TYPE;
(*
```

5.2.2.13 plant_spatial_configuration_person_and_organization_item

A **plant_spatial_configuration_person_and_organization_item** identifies the **change_item**, **plant**, or **site** that is associated with a **person_and_organization**.

EXPRESS specification:

```
*)
TYPE plant_spatial_configuration_person_and_organization_item = SELECT
  (change_item,
   plant,
   site);
END_TYPE;
(*
```

5.2.2.14 purchase_item

A **purchase_item** identifies a **product** that is purchased.

EXPRESS specification:

```
*)
TYPE purchase_item = SELECT
  (product);
END_TYPE;
(*
```

5.2.3 Plant spatial configuration entities

5.2.3.1 Plant spatial configuration entity definitions

5.2.3.1.1 action_request_assignment

A **applied_action_request_assignment** assigns an **action_request** to a set of one or more **product**s.

```
*)
ENTITY applied_action_request_assignment
  SUBTYPE OF (action_request_assignment);
  items : SET [1:?] OF action_request_item;
END_ENTITY;
   (*
```

Attribute definitions:

items: the set of **product**s that an **action_request** is assigned to.

5.2.3.1.2 applied_approval_assignment

An **applied_approval_assignment** assigns an **approval** to a set of one or more **change_action**s.

EXPRESS specification:

```
*)
ENTITY applied_approval_assignment
  SUBTYPE OF (approval_assignment);
  items : SET [1:?] OF approval_item;
END_ENTITY;
(*
```

Attribute definitions:

items: the set of instances of **change_action**, **piping_system**, or **versioned_action_request** to which an **approval** is assigned.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **applied_approval_-assignment** entity:

- **change_life_cycle_stage_usage_requires_approval** (see 5.2.4.7).

5.2.3.1.3 applied_classification_assignment

An **applied_classification_assignment** assigns a classification to a **cableway_system**, **ducting_system**, **electrical_system**, **hvac_component_definition**, **hvac_connector**, **instrumentation_and_control_-system**, **piping_component_definition**, **piping_system**, **plant_item_connection**, **plant_item_-connector**, **applied_document_reference**, **product**, **product_definition**, or **structural_system**.

EXPRESS specification:

```
*)
ENTITY applied_classification_assignment
  SUBTYPE OF (classification_assignment);
  items : SET [1:?] OF classification_item;
WHERE
  WR1: (NOT (SIZEOF (QUERY (item <* SELF.items |
       NOT ('PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTION' IN
       TYPEOF(item)))) = 0)) OR
       (SIZEOF (TYPEOF (SELF.assigned_class) *
       ['PLANT_SPATIAL_CONFIGURATION.CONNECTION_FUNCTIONAL_CLASS',
       'PLANT_SPATIAL_CONFIGURATION.CONNECTION_MOTION_CLASS'])
       >= 1);
  WR2: (NOT (SIZEOF (QUERY (item <* SELF.items |
       NOT ('PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR' IN
       TYPEOF(item)))) = 0)) OR
       (SIZEOF (TYPEOF (SELF.assigned_class) *
       ['PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASS',
       'PLANT_SPATIAL_CONFIGURATION.ELECTRICAL_CONNECTOR_CLASS',
       'PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASS',
       'PLANT_SPATIAL_CONFIGURATION.EXTERNALLY_DEFINED_CLASS',
       'PLANT_SPATIAL_CONFIGURATION.' +
```

```
       'STRUCTURAL_LOAD_CONNECTOR_CLASS']) >= 1);
  WR3: (NOT (SIZEOF (QUERY (item <* SELF.items |
       NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF(item)))) = 0)) OR
       (SIZEOF (TYPEOF (SELF.assigned_class) *
       ['PLANT_SPATIAL_CONFIGURATION.BLANK_FITTING_CLASS',
       'PLANT_SPATIAL_CONFIGURATION.ELBOW_FITTING_CLASS',
       'PLANT_SPATIAL_CONFIGURATION.FLANGE_FITTING_CLASS',
       'PLANT_SPATIAL_CONFIGURATION.' +
       'FLANGE_FITTING_NECK_TYPE_CLASS',
       'PLANT_SPATIAL_CONFIGURATION.PIPE_CLOSURE_FITTING_CLASS',
       'PLANT_SPATIAL_CONFIGURATION.PIPE_CLASS',
       'PLANT_SPATIAL_CONFIGURATION.REDUCER_FITTING_CLASS',
       'PLANT_SPATIAL_CONFIGURATION.SPACER_FITTING_CLASS',
       'PLANT_SPATIAL_CONFIGURATION.SPECIALTY_ITEM_CLASS',
       'PLANT_SPATIAL_CONFIGURATION.SWAGE_FITTING_CLASS',
       'PLANT_SPATIAL_CONFIGURATION.VALVE_CLASS']) >= 1);
END_ENTITY;
(*
```

Attribute definitions:

items: the set of **cableway_system**, **ducting_system**, **electrical_system**, **hvac_component_definition**, **hvac_connector**, **instrumentation_and_control_system**, **piping_component_definition**, **piping_-system**, **plant_item_connection**, **plant_item_connector**, **applied_document_reference**, **product**, **product_definition**, or **structural_system** instances that are assigned to a group.

Formal propositions:

WR1: A **plant_item_connection** shall be assigned either a **connection_functional_class**, a **connection_motion_class**, or a combination of these.

WR2: A **plant_item_connector** shall be assigned either a **connector_end_type_class**, **electrical_-connector_class**, **piping_connector_class**, **structural_load_connector_class**, or a combination of these.

WR3: A **piping_component_definition** shall be assigned either a **blank_fitting_class**, **elbow_fitting_-class**, **flange_fitting_class**, **flange_fitting_neck_type_class**, **pipe_closure_fitting_class**, **pipe_class**, **reducer_fitting_class**, **spacer_fitting_class**, **specialty_item_class**, **swage_fitting_class**, **valve_class**, or a combination of these.

5.2.3.1.4 applied_date_and_time_assignment

An **applied_date_and_time_assignment** assigns a **date_and_time** to a set of one or more **product**s.

EXPRESS specification:

```
*)
ENTITY applied_date_and_time_assignment
  SUBTYPE OF (date_and_time_assignment);
  items : SET [1:?] OF date_and_time_item;
END_ENTITY;
(*
```

Attribute definitions:

items: the set of **product**s that a **date_and_time** is assigned to.

5.2.3.1.5 applied_date_assignment

An **applied_date_assignment** assigns a **date** to a set of one or more **action_directive**s, **change_action**s, **change_item**s, and **product**s.

EXPRESS specification:

```
*)
ENTITY applied_date_assignment
  SUBTYPE OF (date_assignment);
  items : SET [1:?] OF dated_item;
END_ENTITY;
(*
```

Attribute definitions:

items: the set of **action_directive**s, **change_action**s, **change_item**s, and **product**s that a **date** is assigned to.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **applied_date_assignment** entity:

- **change_action_requires_date** (see 5.2.4.4);
- **change_item_requires_creation_date** (see 5.2.4.5).

5.2.3.1.6 applied_document_reference

An **applied_document_reference** assigns a document to a set of one or more instances of **heat_-tracing_representation**, **piping_component_class**, **piping_system**, **plant_item_connector**, **plant_-line_segment_definition**, **product**, **product_definition**, **product_definition_relationship**, **property_-definition**, **representation**, **representation_item**, **site**, **externally_defined_plant_item_definition**, or **material_property**.

EXPRESS specification:

```
*)
ENTITY applied_document_reference
  SUBTYPE OF (document_reference);
  items : SET [1:?] OF document_item;
END_ENTITY;
(*
```

Attribute definitions:

items: the set of instances of **heat_tracing_representation**, **piping_component_class**, **piping_system**, **plant_item_connector**, **plant_line_segment_definition**, **product**, **product_definition**, **product_-definition_relationship**, **property_definition**, **representation**, **representation_item**, **site**, **externally_-defined_plant_item_definition**, or **material_property** that is associated with a **document**.

5.2.3.1.7 applied_identification_assignment

A **applied_identification_assignment** assigns an identifier to a set of one or more instances of **document**,

material_property, **product_definition**, or **shape_aspect**.

EXPRESS specification:

```
*)
ENTITY applied_identification_assignment
  SUBTYPE OF (identification_assignment);
  items : SET [1:?] OF identified_item;
WHERE
  WR1: applied_identification_correlation (SELF);
END_ENTITY;
(*
```

Attribute definitions:

items: the set of instances of **product_definition**, **material_property**, or **document** that an identifier is assigned to.

Formal propositions:

WR1: The **applied_identification_correlation** function that correlates roles of identifiers to elements of product data shall be satisfied.

5.2.3.1.8 blank_fitting_class

A **blank_fitting_class** is a type of **group** that classifies the items that are assigned to it as blank fittings.

EXPRESS specification:

```
*)
ENTITY blank_fitting_class
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
       'ASSIGNED_CLASS') |
       'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ca)) |
       NOT (SIZEOF (QUERY (it <* aca.items |
       NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)))) = 0))) = 0;
  WR2: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
       'ASSIGNED_CLASS') |
       'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ca)) |
       NOT (SIZEOF (QUERY (pcd <* QUERY (it <* aca.items |
       'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)) |
       NOT (SIZEOF (QUERY (aca1 <* USEDIN (pcd.formation.of_product,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
       class_in_tree (aca1.assigned_class, 'blank'))) = 1))) = 0
       ))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **blank_fitting_class** shall classify items of type **piping_component_definition**.

WR2: A **blank_fitting_class** shall classify items of type **piping_component_definition** that are a

definition of a **product** that is classified as a ‘blank’.

5.2.3.1.9 bolt_and_nut_component_class

A **bolt_and_nut_component_class** is a type of **group** that classifies the items that are assigned to it as bolts, nuts, or washers.

EXPRESS specification:

```
*)
ENTITY bolt_and_nut_component_class
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
       'ASSIGNED_CLASS') |
       'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ca)) |
       NOT (SIZEOF (QUERY (it <* aca.items |
       NOT ('PLANT_SPATIAL_CONFIGURATION.BOLT_AND_NUT_COMPONENT_DEFINITION'
       IN TYPEOF (it)))) = 0))) = 0;
  WR2: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
       'ASSIGNED_CLASS') |
       'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ca)) |
       NOT (SIZEOF (QUERY (pcd <* QUERY (it <* aca.items |
       'PLANT_SPATIAL_CONFIGURATION.BOLT_AND_NUT_COMPONENT_DEFINITION' IN
       TYPEOF (it)) |
       NOT (SIZEOF (QUERY (aca1 <* USEDIN (pcd.formation.of_product,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
       class_in_tree (aca1.assigned_class,
       'bolt and nut component'))) = 1))) = 0
       ))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **bolt_and_nut_component_class** shall classify items of type **bolt_and_nut_component_-definition**.

WR2: A **bolt_and_nut_component_class** shall classify items of type **piping_component_definition** that are a definition of a **product** that is classified as a ‘bolt and nut component’.

5.2.3.1.10 bolt_and_nut_component_definition

A **bolt_and_nut_component_definition** is a type of **product_definition** that defines a bolt and nut component.

EXPRESS specification

```
*)
ENTITY bolt_and_nut_component_definition
  SUBTYPE OF (product_definition);
END_ENTITY;
(*
```

5.2.3.1.11 bolt_and_nut_set_definition

A **bolt_and_nut_set_definition** is a type of **product_definition** that defines a bolt and nut set.

EXPRESS specification

```
*)
ENTITY bolt_and_nut_set_definition
  SUBTYPE OF (product_definition);
END_ENTITY;
(*
```

5.2.3.1.12 cableway_component_class

A **cableway_component_class** is a type of **group** that classifies the items that are assigned to it as cableway components. The name of the **cableway_component_class** further classifies the assigned items.

EXPRESS specification:

```
*)
ENTITY cableway_component_class
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'CLASSIFICATION_ASSIGNMENT.ASSIGNED_CLASS') |
       'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ca)) |
       NOT (SIZEOF (QUERY (it <* aca.items |
       NOT ('PLANT_SPATIAL_CONFIGURATION.CABLEWAY_COMPONENT_DEFINITION' IN
       TYPEOF (it)))) = 0))) = 0;
  WR2: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
       'ASSIGNED_CLASS') |
       'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ca)) |
       NOT (SIZEOF (QUERY (pcd <* QUERY (it <* aca.items |
       'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)) |
       NOT (SIZEOF (QUERY (aca1 <* USEDIN (pcd.formation.of_product,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
       class_in_tree (aca1.assigned_class, 'cableway component'))) = 1))) =
0)))
       = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **cableway_component_class** shall classify items of type **cableway_component_definition**.

WR2: A **cableway_component_class** shall classify items of type **cableway_component_definition** that are a definition of a **product** that is classified as a ‘cableway component’.

5.2.3.1.13 cableway_component_definition

A **cableway_component_definition** is a type of **product_definition** that defines a cableway component.

EXPRESS specification

```
*)
ENTITY cableway_component_definition
  SUBTYPE OF (product_definition);
END_ENTITY;
(*
```

5.2.3.1.14 cableway_connector_class

A **cableway_connector_class** is a type of **group** that classifies the items that are assigned to it as being cableway connectors.

EXPRESS specification:

```
*)
ENTITY cableway_connector_class
  SUBTYPE OF (group);
END_ENTITY;
(*
```

5.2.3.1.15 cableway_system

A **cableway_system** is a type of **product_definition** that identifies a system … *(to be completed when corresponding clause 4.2 definition is available).*

EXPRESS specification:

```
*)
ENTITY cableway_system
  SUBTYPE OF (product_definition);
WHERE
  WR1: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
       ('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF
       (pdr.relating_product_definition.formation.of_product)) AND
       (pdr.relating_product_definition.frame_of_reference.name =
       'functional occurrence'))) = 1;
END_ENTITY;
(*
```

Formal propositions:

WR1: The **cableway_system** shall be related to exactly one **product_definition** that is the definition of a plant and has a context of ‘functional occurrence’.

5.2.3.1.16 catalogue

A **catalogue** is a type of**document** defined as an **external_source** that records items whose characteristics are standardized.

NOTE Whether the catalogue is a paper-based or digitally-based catalogue is indicated by the value of the attribute **document_type.product_data_type**. **document_type** is referenced the attribute **kind** inherited from **document**, a supertype of **catalogue**.

EXPRESS specification:

```
*)
ENTITY catalogue
```

```
  SUBTYPE OF (document, external_source);
END_ENTITY;
(*
```

5.2.3.1.17 catalogue_connector

A **catalogue_connector** is a type of**shape_aspect** that is externally defined and identifies a connector whose characteristics are standardised in a library or catalogue.

EXPRESS specification:

```
*)
ENTITY catalogue_connector
  SUBTYPE OF (shape_aspect, externally_defined_item);
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.CHARACTERIZED_OBJECT' IN
       TYPEOF (SELF.of_shape);
  WR2: 'PLANT_SPATIAL_CONFIGURATION.CATALOGUE' IN TYPEOF (SELF.source);
END_ENTITY;
(*
```

Formal propositions:

WR1: The **catalogue_connector** shall be an aspect of the shape of a **characterized_object**.

WR2: The **catalogue_connector** shall have a **catalogue** as its source.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **catalogue_connector** entity:

- **subtype_mandatory_externally_defined_item** (see 5.2.4.16).

5.2.3.1.18 catalogue_item

A **catalogue_item** is an **externally_defined_plant_item_definition** that identifies an item whose characteristics are standardized and have been recorded in a library or catalogue.

EXPRESS specification:

```
*)
ENTITY catalogue_item
  SUBTYPE OF (externally_defined_plant_item_definition);
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.CATALOGUE' IN TYPEOF (SELF.source);
  WR2: SELF.frame_of_reference.name = 'physical definition';
END_ENTITY;
(*
```

Formal propositions:

WR1: A **catalogue_item** shall have a **catalogue** as the **external_source**.

WR2: A **catalogue_item** shall have a **frame_of_reference name** of ‘catalogue definition’.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **catalogue_item** entity:

- **application_context_requires_ap_definition** (see 5.2.4.1);
- **dependent_instantiable_application_context** (see 5.2.4.9);
- **dependent_instantiable_product_definition_context** (see 5.2.4.11);
- **product_definition_context_name_constraint** (see 5.2.4.13);
- **subtype_mandatory_externally_defined_item** (see 5.2.4.16).

5.2.3.1.19 change_action

A **change_action** is a type of **directed_action** that identifies a change, or a request for a change.

EXPRESS specification:

```
*)
ENTITY change_action
  SUBTYPE OF (directed_action);
WHERE
  WR1: SIZEOF (QUERY (ca <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'ACTION_ASSIGNMENT.ASSIGNED_ACTION') |
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PLANT_SPATIAL_CONFIGURATION_CHANGE_ASSIGNMENT' IN
       TYPEOF (ca))) >= 1;
  WR2: SIZEOF (QUERY (ar <* SELF\directed_action.directive.requests |
       NOT (SIZEOF (USEDIN (ar, 'PLANT_SPATIAL_CONFIGURATION.' +
       'ACTION_REQUEST_SOLUTION.REQUEST')) = 1))) = 0;
  WR3: SIZEOF (USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.ACTION_STATUS.' +
       'ASSIGNED_ACTION')) = 1;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **change_action** shall be assigned by at least one **plant_spatial_configuration_change_-assignment**.

WR2: Each **versioned_action_request** that is referenced by a **change_action** shall have exactly one **action_request_solution**.

WR3: Each **change_action** shall be assigned exactly one **action_status**.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **change_action** entity:

- **change_action_requires_date** (see 5.2.4.4);

5.2.3.1.20 change_item_id_assignment

A **change_item_id_assignment** assigns a name to a set of one or moreinstances selected by **change_-item**.

EXPRESS specification:

```
*)
ENTITY change_item_id_assignment
```

```
  SUBTYPE OF (name_assignment);
  items : SET [1:?] OF change_item;
END_ENTITY;
(*
```

Attribute definitions:

items: the set of instances selected by **change_item** to which a name is assigned.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **change_item_id_assignment** entity:

- **change_item_requires_id** (see 5.2.4.6).

5.2.3.1.21 change_life_cycle_stage_assignment

A **change_life_cycle_stage_assignment** is a type of**group_assignment** that classifies a **directed_action** with a life cycle stage class.

EXPRESS specification:

```
*)
ENTITY change_life_cycle_stage_assignment
  SUBTYPE OF (group_assignment);
  items : SET [1:?] OF change_life_cycle_item;
END_ENTITY;
(*
```

Attribute definitions:

items: One or more **directed_action** that is being classified according to a class of life cycle stage by the assigned_group.

5.2.3.1.22 clamp_component_definition

A **clamp_component_definition** is a type of **product_definition** that defines a clamp used to make a connection between plant items.

EXPRESS specification

```
*)
ENTITY clamp_component_definition
  SUBTYPE OF (product_definition);
END_ENTITY;
(*
```

5.2.3.1.23 clamp_set_definition

A **clamp_set_definition** is a type of **product_definition** that defines a collection of clamp components.

EXPRESS specification

```
*)
ENTITY clamp_set_definition
  SUBTYPE OF (product_definition);
   END_ENTITY;
```

```
(*
```

5.2.3.1.24 connection_functional_class

A **connection_functional_class** is a type of**group** that classifies items that are assigned to it as belonging to a common functional class of connections.

EXPRESS specification:

```
*)
ENTITY connection_functional_class
  SUBTYPE OF (group);
END_ENTITY;
(*
```

5.2.3.1.25 connection_material_definition

A **connection_material_definition** is a type of **product_definition** that defines a connection material.

EXPRESS specification

```
*)
ENTITY connection_material_definition
  SUBTYPE OF (product_definition);
END_ENTITY;
(*
```

5.2.3.1.26 connection_motion_class

A **connection_motion_class** is a type of **group** that classifies the connection motion of the items that are assigned to it.

EXPRESS specification:

```
*)
ENTITY connection_motion_class
  SUBTYPE OF (group);
WHERE
  WR1: SELF.name IN ['flexible', 'locked orientation'];
END_ENTITY;
(*
```

Formal propositions:

WR1: The name of the **connection_motion_class** shall be ‘flexible’ or ‘locked orientation’.

5.2.3.1.27 connection_node

A **connection_node** is a type of **shape_aspect** that is part of the definition of a piping system, and connects more than one **line_termination_connection**s.

A **connection_node** shall be used for a connection that involves the termination of more than two lines at a single point. The **connection_node** is the junction for each of the line to line terminations that are involved in the line to line connection.

NOTE There is a 2 or more cardinality between the line connection and line termination. The most common case is

that two line terminations are connected by a line connection, but there are branches where more than 2 lines are terminated at a single line connection. For the case of two lines being terminated, the line to line connection is simply a connection relationship between 2 line terminations. For the more than two, there needs to be a **shape_aspect** that models the connection point at which all of the line terminations are connected. This connection point is represented by the **connection_node**. The **connection_node** represents the logical connection point for all line terminations within a single line connection when there are more than two lines being connected in a single connection.

EXPRESS specification:

```
*)
ENTITY connection_node
  SUBTYPE OF (shape_aspect);
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.PIPING_SYSTEM'
       IN TYPEOF (SELF.of_shape.definition);
  WR2: SIZEOF (QUERY (sar <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.SHAPE_ASPECT_RELATIONSHIP.' +
       'RELATING_SHAPE_ASPECT') |
       'PLANT_SPATIAL_CONFIGURATION.LINE_TERMINATION_CONNECTION' IN
       TYPEOF (sar))) >= 2;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **connection_node** shall be an aspect of the definition of the shape of a **piping_system**.

WR2: A **connection_node** shall be the **relating_shape_aspect** for at least two **line_termination_-connection**s.

5.2.3.1.28 connector_end_type_class

A **connector_end_type_class** is a type of **group** that classifies the end type of the connectors that are assigned to it.

EXPRESS specification:

```
*)
ENTITY connector_end_type_class
  SUBTYPE OF (group);
END_ENTITY;
(*
```

5.2.3.1.29 descriptive_colour

A **descriptive_colour** is a type of **descriptive_representation_item** that identifies a colour.

EXPRESS specification:

```
*)
ENTITY descriptive_colour
  SUBTYPE OF (colour, descriptive_representation_item);
END_ENTITY;
(*
```

5.2.3.1.30 design_project

A **design_project** is a type of **organization** that identifies a task with a defined scope and purpose.

EXPRESS specification:

```
*)
ENTITY design_project
  SUBTYPE OF (organization);
WHERE
  WR1: SIZEOF (USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'ORGANIZATION_ASSIGNMENT.ASSIGNED_ORGANIZATION')) >= 1;
END_ENTITY;
(*
```

Formal propositions:

WR1: Each **design_project** shall be assigned to product data by at least one **organization_assignment**.

5.2.3.1.31 design_project_assignment

A **design_project_assignment** assigns a **product_definition** to a **design_project**.

EXPRESS specification:

```
*)
ENTITY design_project_assignment
  SUBTYPE OF (organization_assignment);
  items : SET [1:?] OF design_project_item;
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.DESIGN_PROJECT' IN
       TYPEOF (SELF.assigned_organization);
END_ENTITY;
(*
```

Attribute definitions:

items: the set of **product_definition**s that are assigned to a **design_project**.

Formal propositions:

WR1: The **organization** that is assigned by a **design_project_assignment** shall be a **design_project**.

5.2.3.1.32 ducting_system

A **ducting_system** is a type of **product_definition** that identifies a system that controls the temperature, humidity, cleanliness, and circulation of environmental air.

EXPRESS specification:

```
*)
ENTITY ducting_system
  SUBTYPE OF (product_definition);
WHERE
  WR1: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
       ('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF
       (pdr.relating_product_definition.formation.of_product)) AND
       (pdr.relating_product_definition.frame_of_reference.name =
       'functional occurrence'))) = 1;
END_ENTITY;
(*
```

Formal propositions:

WR1: The **ducting_system** shall be related to exactly one **product_definition** that is the definition of a plant and has a context of ‘functional occurrence’.

5.2.3.1.33 elbow_fitting_class

An **elbow_fitting_class** is a type of group that classifies the items that are assigned to it as elbow fittings. The name of the **elbow_fitting_class** further classifies the assigned items.

EXPRESS specification:

```
*)
ENTITY elbow_fitting_class
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'CLASSIFICATION_ASSIGNMENT.ASSIGNED_CLASS') |
       'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ca)) |
       NOT (SIZEOF (QUERY (it <* aca.items |
       NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)))) = 0))) = 0;
  WR2: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
       'ASSIGNED_CLASS') |
       'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ca)) |
       NOT (SIZEOF (QUERY (pcd <* QUERY (it <* aca.items |
       'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)) |
       NOT (SIZEOF (QUERY (aca1 <* USEDIN (pcd.formation.of_product,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
       class_in_tree (aca1.assigned_class, 'elbow'))) = 1))) = 0)))
       = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: An **elbow_fitting_class** shall classify items of type **piping_component_definition**.

WR2: An **elbow_fitting_class** shall classify items of type **piping_component_definition** that are a definition of a **product** that is classified as a ‘elbow’.

5.2.3.1.34 electrical_connector_class

An **electrical_connector_class** is a type of **group** that classifies the items that are assigned to it as being electrical connectors. The name of the **electrical_connector_class** further classifies the assigned items.

EXPRESS specification:

```
*)
ENTITY electrical_connector_class
  SUBTYPE OF (group);
END_ENTITY;
(*
```

5.2.3.1.35 electrical_system

An **electrical_system** is a type of **product_definition** that identifies a system of wiring, switches, relays and other equipment associated with receiving and distributing electrical power.

EXPRESS specification:

```
*)
ENTITY electrical_system
  SUBTYPE OF (product_definition);
WHERE
  WR1: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
       ('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF
       (pdr.relating_product_definition.formation.of_product)) AND
       (pdr.relating_product_definition.frame_of_reference.name =
       'functional occurrence'))) = 1;
END_ENTITY;
(*
```

Formal propositions:

WR1: The **electrical_system** shall be related to exactly one **product_definition** that is the definition of a plant and has a context of ‘functional occurrence’.

5.2.3.1.36 externally_defined_class

An **externally_defined_class** is a type of**group** that classifies an item and is defined by reference to an external source.

NOTE An external source can be an ISO 13584 classification table [13]. This source should be specified as a **known_source** (see 5.2.3.1.52) and referenced with **externally_defined_item.source**.

EXPRESS specification:

```
*)
ENTITY externally_defined_class
  SUBTYPE OF (group, externally_defined_item);
WHERE
  WR1: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
       'ASSIGNED_CLASS') |
       'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ca)) |
       NOT (SIZEOF (QUERY (it <* aca.items |
       NOT ((SIZEOF (TYPEOF (it) *
       ['PLANT_SPATIAL_CONFIGURATION.ELECTRICAL_SYSTEM',
       'PLANT_SPATIAL_CONFIGURATION.DUCTING_SYSTEM',
       'PLANT_SPATIAL_CONFIGURATION.INSTRUMENTATION_AND_CONTROL_SYSTEM',
       'PLANT_SPATIAL_CONFIGURATION.PIPING_SYSTEM',
       'PLANT_SPATIAL_CONFIGURATION.PLANT',
       'PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR',
       'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION',
       'PLANT_SPATIAL_CONFIGURATION.STRUCTURAL_SYSTEM']) = 1) OR
       (('PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION'
       IN TYPEOF (it)) AND
       (SIZEOF (QUERY (pc <*
       it.formation.of_product.frame_of_reference |
       pc.discipline_type = 'process plant')) = 1))))) = 0))) = 0;
END_ENTITY;
(*
```

Formal proposition:

WR1: An **externally_defined_class** shall classify either an **electrical_system**, **ducting_system**, **instrumentation_and_control_system**, **piping_system**, **plant**, **plant_item_connector**, **piping_-component_definition**, **structural_system**, or **product_definition** that is the definition of a plant item.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **externally_defined_class** entity:

- **subtype_mandatory_externally_defined_item** (see 5.2.4.16);
- **subtype_mandatory_pre_defined_item** (see 5.2.4.17).

5.2.3.1.37 externally_defined_document

An **externally_defined_document** is a type of **document** that is defined by reference to an external source.

EXPRESS specification:

```
*)
ENTITY externally_defined_document
  SUBTYPE OF (document, externally_defined_item);
END_ENTITY;
(*
```

5.2.3.1.38 externally_defined_plant_item_definition

An **externally_defined_plant_item_definition** is a type of**product_definition** that identifies an item or piece of equipment that may be used as a component of a plant and is defined by reference to an external source.

NOTE An external source can be a ISO 13584 library [13]. This source should be specified as a **known_source** (see 5.2.3.1.52) and referenced with **externally_defined_item.source**.

EXPRESS specification:

```
*)
ENTITY externally_defined_plant_item_definition
  SUBTYPE OF (product_definition, externally_defined_item);
END_ENTITY;
(*
```

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **externally_defined_plant_-item_definition** entity:

- **application_context_requires_ap_definition** (see 5.2.4.1);
- **dependent_instantiable_application_context** (see 5.2.4.9);
- **dependent_instantiable_product_context** (see 5.2.4.10);

- **dependent_instantiable_product_definition_context** (see 5.2.4.11);
- **product_context_discipline_type_constraint** (see 5.2.4.12);
- **product_definition_context_name_constraint** (see 5.2.4.13);
- **subtype_mandatory_externally_defined_item** (see 5.2.4.16);
- **subtype_mandatory_pre_defined_item** (see 5.2.4.17).

5.2.3.1.39 externally_defined_representation_item

An **externally_defined_representation_item** is a type of**representation_item** that has meaning defined in a source outside of this part of ISO 10303.

EXPRESS specification:

```
*)
ENTITY externally_defined_representation_item
  SUBTYPE OF (representation_item, externally_defined_item);
END_ENTITY;
(*
```

5.2.3.1.40 flange_fitting_class

A **flange_fitting_class** is a type of **group** that classifies the items that are assigned to it as flange fittings.

EXPRESS specification:

```
*)
ENTITY flange_fitting_class
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'CLASSIFICATION_ASSIGNMENT.ASSIGNED_CLASS') |
       'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ca)) |
       NOT (SIZEOF (QUERY (it <* aca.items |
       NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)))) = 0))) = 0;
  WR2: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'CLASSIFICATION_ASSIGNMENT.ASSIGNED_CLASS') |
       'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ca)) |
       NOT (SIZEOF (QUERY (pcd <* QUERY (it <* aca.items |
       'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)) |
       NOT (SIZEOF (QUERY (aca1 <* USEDIN (pcd.formation.of_product,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
       class_in_tree (aca1.assigned_class, 'flange'))) = 1))) = 0)))
       = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **flange_fitting_class** shall classify items of type **piping_component_definition**.

WR2: A **flange_fitting_class** shall classify items of type **piping_component_definition** that are a definition of a **product** that is categorized as a ‘flange’.

5.2.3.1.41 flange_fitting_neck_type_class

A **flange_fitting_neck_type_class** is a type of **group** that classifies the neck type of the flange fittings items that are assigned to it.

EXPRESS specification:

```
*)
ENTITY flange_fitting_neck_type_class
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
       'ASSIGNED_CLASS') |
       'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ca)) |
       NOT (SIZEOF (QUERY (it <* aca.items |
       NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)))) = 0))) = 0;
  WR2: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
       'ASSIGNED_CLASS') |
       'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ca)) |
       NOT (SIZEOF (QUERY (pcd <* QUERY (it <* aca.items |
       'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)) |
       NOT (SIZEOF (QUERY (aca1 <* USEDIN (pcd.formation.of_product,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
       class_in_tree (aca1.applied_classification, 'flange')))
       = 1))) = 0))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **flange_fitting_neck_type_classification** shall classify items of type **piping_component_-definition**.

WR2: A **flange_fitting_neck_type_classification** shall classify items of type **piping_component_-definition** that are a definition of a **product** that is categorized as a ‘flange’.

5.2.3.1.42 heat_tracing_representation

A **heat_tracing_representation** is a type of**representation** that represents the means utilized to impart a temperature increase by an external wrapping or coiling.

EXPRESS specification:

```
*)
ENTITY heat_tracing_representation
  SUBTYPE OF (representation);
END_ENTITY;
(*
```

5.2.3.1.43 hvac_branch_connection

An **hvac_branch_connection** is a type of **shape_aspect_relationship** that identifies the connection between an HVAC section segment and a branch.

EXPRESS specification:

```
*)
ENTITY hvac_branch_connection
  SUBTYPE OF (shape_aspect_relationship);
WHERE
  WR1: SELF.description = 'branch location';
  WR2: 'PLANT_SPATIAL_CONFIGURATION.HVAC_SECTION_SEGMENT_DEFINITION'
       IN TYPEOF (SELF.relating_shape_aspect.of_shape.definition);
  WR3: 'PLANT_SPATIAL_CONFIGURATION.HVAC_SECTION_SEGMENT_TERMINATION'
       IN TYPEOF (SELF.related_shape_aspect);
END_ENTITY;
(*
```

Formal propositions:

WR1: The value of **hvac_branch_connection.description** shall be ‘branch location’.

WR2: The **product_definition** that the **relating_shape_aspect** of an **hvac_branch_connection** is related to shall be an **hvac_section_segment_definition**.

WR3: The **related_shape_aspect** of an **hvac_branch_connection** shall be an **hvac_section_segment_-termination**.

5.2.3.1.44 hvac_component_definition

An **hvac_component_definition** is a type of **product_definition** that defines an HVAC component.

EXPRESS specification

```
*)
ENTITY hvac_component_definition
  SUBTYPE OF (product_definition);
END_ENTITY;
(*
```

5.2.3.1.45 hvac_connector

An **hvac_connector** is a type of **shape_aspect** that identifies a feature of a plant item that is designed to connect to another connector.

EXPRESS specification:

```
*)
ENTITY hvac_connector
  SUBTYPE OF(shape_aspect);
WHERE
  WR1: SELF\shape_aspect.of_shape\property_definition.
       definition\product_definition.
       frame_of_reference\application_context_element.name IN
       ['functional definition', 'physical definition',
       'functional occurrence', 'physical occurrence'];
  WR2: (NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
       pd.name = 'hvac service characteristics')) >= 1)) OR
```

```
      (SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      pd.name = 'hvac service characteristics') |
      NOT (SIZEOF (QUERY (pdr <* USEDIN (sc,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name =
      'design service characteristics')) = 1))) = 0);
  WR3: (NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      (pd.name = 'hvac service characteristics') )) >= 1)) OR
      (SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      pd.name = 'hvac service characteristics') |
      NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'design service characteristics') |
      SIZEOF (dsc.used_representation.items) >= 2)) = 1))) = 0);
  WR4: ((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      pd.name = 'hvac service characteristics')) >= 1)) OR
      (SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      pd.name = 'hvac service characteristics') |
      NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'design service characteristics') |
      {1 <= SIZEOF (QUERY (it <* dsc.used_representation.items |
      ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
      TYPEOF (it)) AND
      (it.name IN ['pressure', 'minimum pressure',
      'maximum pressure']))) <= 2})) = 1))) = 0));
  WR5: ((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      pd.name = 'hvac service characteristics')) >= 1)) OR
      (SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      pd.name = 'hvac service characteristics') |
      NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'design service characteristics') |
      SIZEOF (QUERY (it <* dsc.used_representation.items |
      ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
      TYPEOF (it)) AND
      (it.name = 'pressure'))) <= 1)) = 1))) = 0));
  WR6: ((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      pd.name = 'hvac service characteristics')) >= 1)) OR
      (SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      pd.name = 'hvac service characteristics') |
      NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'design service characteristics') |
      SIZEOF (QUERY (it <* dsc.used_representation.items |
      ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
      TYPEOF (it)) AND
      (it.name = 'minimum pressure'))) <= 1)) = 1))) = 0));
  WR7: ((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      pd.name = 'hvac service characteristics')) >= 1)) OR
      (SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      pd.name = 'hvac service characteristics') |
      NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
      'PLANT_SPATIAL_CONFIGURATION.' +
```

```
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'design service characteristics') |
      SIZEOF (QUERY (it <* dsc.used_representation.items |
      ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
      TYPEOF (it)) AND
      (it.name = 'maximum pressure'))) <= 1)) = 1))) = 0));
 WR8: ((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      pd.name = 'hvac service characteristics')) >= 1)) OR
      (SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      pd.name = 'hvac service characteristics') |
      NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'design service characteristics') |
      {1 <= SIZEOF (QUERY (it <* dsc.used_representation.items |
      (SIZEOF (TYPEOF (it) *
      ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.' +
      'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
      (it.name IN ['temperature', 'minimum temperature',
      'maximum temperature'])))) <= 2})) = 1))) = 0));
 WR9: ((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      pd.name = 'hvac service characteristics')) >= 1)) OR
      (SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      pd.name = 'hvac service characteristics') |
      NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'design service characteristics') |
      SIZEOF (QUERY (it <* dsc.used_representation.items |
      (SIZEOF (TYPEOF (it) *
      ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.' +
      'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
      (it.name = 'temperature'))) <= 1)) = 1))) = 0));
WR10: ((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      pd.name = 'hvac service characteristics')) >= 1)) OR
      (SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      pd.name = 'hvac service characteristics') |
      NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'design service characteristics') |
      SIZEOF (QUERY (it <* dsc.used_representation.items |
      (SIZEOF (TYPEOF (it) *
      ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.' +
      'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
      (it.name = 'minimum temperature'))) <= 1)) = 1))) = 0));
WR11: ((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      pd.name = 'hvac service characteristics')) >= 1)) OR
      (SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      pd.name = 'hvac service characteristics') |
      NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'design service characteristics') |
      SIZEOF (QUERY (it <* dsc.used_representation.items |
      (SIZEOF (TYPEOF (it) *
      ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.' +
      'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
```

```
       (it.name = 'maximum temperature'))) <= 1)) = 1))) = 0));
 WR12: (NOT (SELF\shape_aspect.of_shape\property_definition.
       definition\product_definition.
       frame_of_reference\application_context_element.name IN
       ['functional definition', 'functional occurrence'])) OR
       (SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       'PLANT_SPATIAL_CONFIGURATION.SHAPE_REPRESENTATION' IN
       TYPEOF (pdr.used_representation))) = 0);
END_ENTITY;
(*
```

Formal propositions:

WR1: The **application_context_element** that applies to an **hvac_connector** (as its **product_-definition_context**) shall have the name ‘functional occurrence’.

WR2: If the **hvac_connector** has a **property_definition** with a name of ‘hvac service characteristics’, the **property_definition** shall have exactly one **representation** with the name of ‘design service characteristics’.

WR3: If the **hvac_connector** has a **property_definition** with a name of ‘hvac service characteristics’, the **property_definition** shall have exactly one **representation** with a name of ‘design service characteristics’ that has at least two **representation_item**s.

WR4: If the **hvac_connector** has a **property_definition** with a name of ‘hvac service characteristics’, the **property_definition** shall have exactly one **representation** with a name of ‘design service characteristics’ that has one or two **representation_item**s of type **measure_representation_item** with a name of ‘pressure’, ‘minimum pressure’, or ‘maximum pressure’.

WR5: If the **hvac_connector** has a **property_definition** with a name of ‘hvac service characteristics’, the **property_definition** shall have exactly one **representation** with a name of ‘design service characteristics’ that has at most one **representation_item** of type **measure_representation_item** with a name of ‘pressure’.

WR6: If the **hvac_connector** has a **property_definition** with a name of ‘hvac service characteristics’, the **property_definition** shall have exactly one **representation** with a name of ‘design service characteristics’ that has at most one **representation_item** of type **measure_representation_item** with a name of ‘minimum pressure’.

WR7: If the **hvac_connector** has a **property_definition** with a name of ‘hvac service characteristics’, the **property_definition** shall have exactly one **representation** with a name of ‘design service characteristics’ that has at most one **representation_item** of type **measure_representation_item** with a name of ‘maximum pressure’.

WR8: If the **hvac_connector** has a **property_definition** with a name of ‘hvac service characteristics’, the **property_definition** shall have exactly one **representation** with a name of ‘design service characteristics’ that has one or two **representation_item**s of type **measure_representation_item** and **thermodynamic_temperature_measure_with_unit** with a name of ‘temperature’, ‘minimum temperature’, or ‘maximum temperature’.

WR9: If the **hvac_connector** has a **property_definition** with a **name** of ‘hvac service characteristics’, the **property_definition** shall have exactly one **representation** with a **name** of ‘design service characteristics’ that has at most one **representation_item** of type **measure_representation_item** and **thermodynamic_temperature_measure_with_unit** with a **name** of ‘temperature’.

WR10: If the **hvac_connector** has a **property_definition** with a **name** of 'hvac service characteristics', the **property_definition** shall have exactly one **representation** with a **name** of 'design service characteristics' that has at most one **representation_item** of type **measure_representation_item** and **thermodynamic_temperature_measure_with_unit** with a **name** of 'minimum temperature'.

WR11: If the **hvac_connector** has a **property_definition** with a **name** of 'hvac service characteristics', the **property_definition** shall have exactly one **representation** with a **name** of 'design service characteristics' that has at most one **representation_item** of type **measure_representation_item** and **thermodynamic_temperature_measure_with_unit** with a **name** of 'maximum temperature'.

WR12: If an **hvac_connector** is a type offunctional connector it shall not have any **shape_-representation**.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **plant_item_connector** entity:

- **application_context_requires_ap_definition** (see 5.2.4.1);
- **dependent_instantiable_application_context** (see 5.2.4.9);
- **dependent_instantiable_product_definition_context** (see 5.2.4.11);
- **product_definition_context_name_constraint** (see 5.2.4.13);
- **product_definition_usage_constraint** (see 5.2.4.14).

5.2.3.1.46 hvac_cross_section

An **hvac_cross_section** is a type of **shape_aspect** that specifies the cross section of an HVAC connector.

EXPRESS specification:

```
*)
ENTITY hvac_cross_section
  SUBTYPE OF (shape_aspect);
END_ENTITY;
(*
```

5.2.3.1.47 hvac_fitting_class

An **hvac_fitting_class** is a type of **group** that classifies the items that are assigned to it as HVAC fittings.

EXPRESS specification:

```
*)
ENTITY hvac_fitting_class
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
       'ASSIGNED_CLASS') |
       'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ca)) |
       NOT (SIZEOF (QUERY (it <* aca.items |
       NOT ('PLANT_SPATIAL_CONFIGURATION.HVAC_COMPONENT_DEFINITION' IN
       TYPEOF (it)))) = 0))) = 0;
```

```
  WR2: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
       'ASSIGNED_CLASS') |
       'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ca)) |
       NOT (SIZEOF (QUERY (pcd <* QUERY (it <* aca.items |
       'PLANT_SPATIAL_CONFIGURATION.HVAC_COMPONENT_DEFINITION' IN
       TYPEOF (it)) |
       NOT (SIZEOF (QUERY (aca1 <* USEDIN (pcd.formation.of_product,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
       class_in_tree (aca1.assigned_class, 'hvac fitting')))
       = 1))) = 0))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: An **hvac_fitting_class** shall classify items of type **hvac_component_definition**.

WR2: An **hvac_fitting_class** shall classify items of type **hvac_component_definition** that are a definition of a **product** that is categorized as a ‘hvac fitting’.

5.2.3.1.48 hvac_plant_item_branch_connection

An **hvac_plant_item_branch_connection** is a type of**shape_aspect_relationship** that identifies the connection between an HVAC section segment and an hvac connector that branches from the segment.

EXPRESS specification:

```
*)
ENTITY hvac_plant_item_branch_connection
  SUBTYPE OF (shape_aspect_relationship);
WHERE
  WR1: SELF.description = 'branch location';
  WR2: 'PLANT_SPATIAL_CONFIGURATION.HVAC_SECTION_SEGMENT_DEFINITION'
       IN TYPEOF (SELF.relating_shape_aspect.of_shape.definition);
  WR3: 'PLANT_SPATIAL_CONFIGURATION.HVAC_CONNECTOR'
       IN TYPEOF (SELF.related_shape_aspect);
END_ENTITY;
(*
```

Formal propositions:

WR1: The value of **hvac_plant_item_branch_connection.description** shall be ‘branch location’.

WR2: The **product_definition** that the **relating_shape_aspect** of an **hvac_plant_item_branch_-connection** is related to shall be an **hvac_section_segment_definition**.

WR3: The **related_shape_aspect** of an **hvac_branch_connection** shall be an **hvac_connector**.

5.2.3.1.49 hvac_plant_item_connection

An **hvac_plant_item_ connection** is a type of**shape_aspect_relationship** that identifies the connection between an HVAC plant item termination and an HVAC connector.

EXPRESS specification:

```
*)
ENTITY hvac_plant_item_connection
     SUBTYPE OF (shape_aspect_relationship);
```

```
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.HVAC_SECTION_SEGMENT_TERMINATION'
       IN TYPEOF (SELF.relating_shape_aspect);
  WR2: 'PLANT_SPATIAL_CONFIGURATION.HVAC_CONNECTOR'
       IN TYPEOF (SELF.related_shape_aspect);
  WR3: SELF\shape_aspect_relationship.related_shape_aspect.
       of_shape\property_definition.
       definition\product_definition.
       frame_of_reference\application_context_element.
       name = 'physical occurrence';
END_ENTITY;
(*
```

Formal propositions:

WR1: The **relating_shape_aspect** of an **hvac_plant_item_connection** shall be an **hvac_section_-segment_termination**.

WR2: The **related_shape_aspect** of an **hvac_plant_item_connection** shall be an **hvac_connector**.

WR3: The **product_definition** that the **related_shape_aspect** of an **hvac_plant_item_connection** is related to shall have a context with the name ‘physical occurrence’.

5.2.3.1.50 hvac_section_segment_definition

An **hvac_section_segment_definition** is a type of **product_definition** that identifies an HVAC section segment.

EXPRESS specification:

```
*)
ENTITY hvac_section_segment_definition
  SUBTYPE OF (product_definition);
WHERE
  WR1: SIZEOF (QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
       'PLANT_SPATIAL_CONFIGURATION.HVAC_SYSTEM_SECTION_DEFINITION'
       IN TYPEOF (pdr.relating_product_definition))) >= 1;
  WR2: SIZEOF (QUERY( pd <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
       'PLANT_SPATIAL_CONFIGURATION.SHAPE_DEFINITION' IN
       TYPEOF (pd))) >= 1;
  WR3: SELF.frame_of_reference\application_context_element.name =
       'functional definition';
  WR4: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name =
       'hvac section segment characteristics')) = 1;
  WR5: SIZEOF (QUERY (hssc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name =
       'hvac section segment characteristics') |
       NOT ({1 <= SIZEOF (QUERY (it <* hssc.used_representation.items |
       (it.name IN ['pressure drop',
       'maximum pressure drop', 'minimum pressure drop ']))) <= 2}))) = 0;
  WR6: SIZEOF (QUERY (hssc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name =
       'hvac section segment characteristics') |
       NOT (SIZEOF (QUERY (it <* hssc.used_representation.items |
       ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
       TYPEOF (it)) AND
```

```
      (it.name = 'pressure drop'))) <= 1))) = 0;
  WR7: SIZEOF (QUERY (hssc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name =
      'hvac section segment characteristics') |
      NOT (SIZEOF (QUERY (it <* hssc.used_representation.items |
      ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
      TYPEOF (it)) AND
      (it.name = 'minimum pressure drop'))) <= 1))) = 0;
  WR8: SIZEOF (QUERY (hssc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name =
      'hvac section segment characteristics') |
      NOT (SIZEOF (QUERY (it <* hssc.used_representation.items |
      ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
      TYPEOF (it)) AND
      (it.name = 'maximum pressure drop'))) <= 1))) = 0;
  WR9: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
      pdr.name = 'hvac segment insulation')) >= 1)) OR
      (SIZEOF (QUERY (si <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
      pdr.name = 'hvac segment insulation') |
      NOT (SIZEOF (QUERY (pd <* USEDIN (si,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      NOT (SIZEOF (QUERY (pds <* QUERY (pdr <* USEDIN (pd,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
      TYPEOF (pdr)) |
      pds.used_representation.name =
      'hvac segment insulation characteristics')) = 1))) = 0))) = 0);
 WR10: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
      pdr.name = 'hvac segment insulation')) >= 1)) OR
      (SIZEOF (QUERY (si <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
      pdr.name = 'hvac segment insulation') |
      NOT (SIZEOF (QUERY (pd <* USEDIN (si,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      NOT (SIZEOF (QUERY (sic <* QUERY (pds <* QUERY (pdr <* USEDIN (pd,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
      TYPEOF (pdr)) |
      pds.used_representation.name =
      'hvac segment insulation characteristics') |
      SIZEOF (sic.used_representation.items) >= 1)) = 1))) = 0))) = 0);
 WR11: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
      pdr.name = 'hvac segment insulation')) >= 1)) OR
      (SIZEOF (QUERY (si <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
      pdr.name = 'hvac segment insulation') |
      NOT (SIZEOF (QUERY (pd <* USEDIN (si,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      NOT (SIZEOF (QUERY (sic <* QUERY (pds <* QUERY (pdr <* USEDIN (pd,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
      TYPEOF (pdr)) |
      pds.used_representation.name =
```

```
      'hvac segment insulation characteristics') |
      {1 <= SIZEOF (QUERY (it <* sic.used_representation.items |
      (SIZEOF (TYPEOF (it) *
      ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']) = 2) AND
      (it.name IN ['thickness', 'minimum thickness',
      'maximum thickness'])) <= 2})) = 1))) = 0))) = 0);
WR12: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
      pdr.name = 'hvac segment insulation')) >= 1)) OR
      (SIZEOF (QUERY (si <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
      pdr.name = 'hvac segment insulation') |
      NOT (SIZEOF (QUERY (pd <* USEDIN (si,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      NOT (SIZEOF (QUERY (sic <* QUERY (pds <* QUERY (pdr <* USEDIN (pd,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
      TYPEOF (pdr)) |
      pds.used_representation.name =
      'segment insulation characteristics') |
      SIZEOF (QUERY (it <* sic.used_representation.items |
      (SIZEOF (TYPEOF (it) *
      ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']) = 2) AND
      (it.name = 'thickness'))) <= 1)) = 1))) = 0))) = 0);
WR13: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
      pdr.name = 'segment insulation')) >= 1)) OR
      (SIZEOF (QUERY (si <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
      pdr.name = 'hvac segment insulation') |
      NOT (SIZEOF (QUERY (pd <* USEDIN (si,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      NOT (SIZEOF (QUERY (sic <* QUERY (pds <* QUERY (pdr <* USEDIN (pd,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
      TYPEOF (pdr)) |
      pds.used_representation.name =
      'hvac segment insulation characteristics') |
      SIZEOF (QUERY (it <* sic.used_representation.items |
      (SIZEOF (TYPEOF (it) *
      ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']) = 2) AND
      (it.name = 'minimum thickness'))) <= 1)) = 1))) = 0))) = 0);
WR14: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
      pdr.name = 'hvac segment insulation')) >= 1)) OR
      (SIZEOF (QUERY (si <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
      pdr.name = 'hvac segment insulation') |
      NOT (SIZEOF (QUERY (pd <* USEDIN (si,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      NOT (SIZEOF (QUERY (sic <* QUERY (pds <* QUERY (pdr <* USEDIN (pd,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
      TYPEOF (pdr)) |
      pds.used_representation.name =
      'hvac segment insulation characteristics') |
      SIZEOF (QUERY (it <* sic.used_representation.items |
      (SIZEOF (TYPEOF (it) *
```

```
       ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
       'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']) = 2) AND
       (it.name = 'maximum thickness'))) <= 1)) = 1))) = 0))) = 0);
WR15: SIZEOF (QUERY (pds <* QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
      TYPEOF (pd)) |
      NOT (SIZEOF (QUERY (sa <*USEDIN (pds,
      'PLANT_SPATIAL_CONFIGURATION.SHAPE_ASPECT.OF_SHAPE') |
      'PLANT_SPATIAL_CONFIGURATION.HVAC_SECTION_SEGMENT_TERMINATION' IN
      TYPEOF (sa))) = 2))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: An **hvac_sectionsegment_definition** shall be the **related_product_definition** in a **product_-definition_relationship** that has a **relating_product_definition** that is an **hvac_system_section_-definition**.

WR2: An **hvac_section_segment_definition** shall be referenced by a **shape_definition**.

WR3: An **hvac_section_segment_definition** shall have a **frame_of_reference name** of ‘functional definition’.

WR4: An **hvac_section_segment_definition** shall have exactly one representation with the name of ‘hvac section segment characteristics’.

WR5: The representation of the **hvac_section_segment_definition** with the name of ‘hvac section segment characteristics’ shall have between one and two **representation_item**s with a name of ‘pressure drop’, 'maximum pressure drop', or 'minimum pressure drop'.

WR6: The representation of the **hvac_section_segment_definition** with the name of ‘hvac section segment characteristics’ shall have at most one **representation_item** of type **measure_representation_-item** with a name of ‘pressure drop’.

WR7: The representation of the **hvac_section_segment_definition** with the name of ‘hvac section segment characteristics’ shall have at most one **representation_item** of type **measure_representation_-item** with a name of ‘minimum pressure drop’.

WR8: The representation of the **hvac_section_segment_definition** with the name of ‘hvac section segment characteristics’ shall have at most one **representation_item** of type **measure_representation_-item** with a name of ‘maximum pressure drop’.

WR9 If the **hvac_section_segment_definition** is related to a **product_definition** as an ‘hvac segment insulation’, the **product_definition** shall have a **product_definition_shape** that has exactly one **representation** with the **name** of ‘hvac segment insulation characteristics’.

WR10: If the **hvac_section_segment_definition** is related to a **product_definition** as an ‘hvac segment insulation’, the **product_definition** shall have a **product_definition_shape** that has exactly one **representation** with the **name** of ‘hvac segment insulation characteristics’ that has at least one **representation_item**.

WR11: If the **hvac_section_segment_definition** is related to a **product_definition** as an ‘hvac segment insulation’, the **product_definition** shall have a **product_definition_shape** that has exactly one **representation** with the **name** of ‘hvac segment insulation characteristics’ that has one or two **representation_item**s of type **measure_representation_item** and **length_measure_with_unit** with a

name of ‘thickness’, ‘minimum thickness’, or ‘maximum thickness’.

WR12: If the **hvac_section_segment_definition** is related to a **product_definition** as an ‘hvac segment insulation’, the **product_definition** shall have a **product_definition_shape** that has exactly one **representation** with the **name** of ‘hvac segment insulation characteristics’ that has at most one **representation_item** items of type **measure_representation_item** and **length_measure_with_unit** with a **name** of ‘thickness’.

WR13: If the **hvac_section_segment_definition** is related to a **product_definition** as an ‘hvac segment insulation’, the **product_definition** shall have a **product_definition_shape** that has exactly one **representation** with the **name** of ‘hvac segment insulation characteristics’ that has at most one **representation_item** items of type **measure_representation_item** and **length_measure_with_unit** with a **name** of ‘minimum thickness’.

WR14: If the **hvac_section_segment_definition** is related to a **product_definition** as an ‘hvac segment insulation’, the **product_definition** shall have a **product_definition_shape** that has exactly one **representation** with the **name** of ‘hvac segment insulation characteristics’ that has at most one **representation_item** items of type **measure_representation_item** and **length_measure_with_unit** with a **name** of ‘maximum thickness’.

WR15: The **hvac_section_segment_definition** shall be related to exactly two instances of **hvac_-section_segment_termination**.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **hvac_section_segment_-definition** entity:

- **application_context_requires_ap_definition** (see 5.2.4.1);
- **dependent_instantiable_application_context** (see 5.2.4.9);
- **dependent_instantiable_product_definition_context** (see 5.2.4.11);
- **product_definition_context_name_constraint** (see 5.2.4.13).

5.2.3.1.51 hvac_section_segment_termination

An **hvac_section_segment_termination** is a type of **shape_aspect** that identifies the termination of an HVAC section segment.

EXPRESS specification:

```
*)
ENTITY hvac_section_segment_termination
  SUBTYPE OF (shape_aspect);
WHERE
  WR1: SIZEOF (QUERY (sar <*
       USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'SHAPE_ASPECT_RELATIONSHIP.RELATING_SHAPE_ASPECT') +
       USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'SHAPE_ASPECT_RELATIONSHIP.RELATED_SHAPE_ASPECT') |
       NOT (SIZEOF (TYPEOF (sar) *
       ['PLANT_SPATIAL_CONFIGURATION.HVAC_BRANCH_CONNECTION',
       'PLANT_SPATIAL_CONFIGURATION.HVAC_PLANT_ITEM_CONNECTION',
       'PLANT_SPATIAL_CONFIGURATION.HVAC_TERMINATION_CONNECTION'])
       = 1))) = 0;
```

```
  WR2: SIZEOF (QUERY (sar <*
       USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.'+
       'SHAPE_ASPECT_RELATIONSHIP.RELATED_SHAPE_ASPECT') |
       SIZEOF (TYPEOF (sar) *
       ['PLANT_SPATIAL_CONFIGURATION.HVAC_BRANCH_CONNECTION',
       'PLANT_SPATIAL_CONFIGURATION.HVAC_PLANT_ITEM_CONNECTION']) = 1))= 1;
END_ENTITY;
(*
```

Formal propositions:

WR1: An **hvac_section_segment_termination** is the **relating_shape_aspect** or the **related_shape_-aspect** in at least one **shape_aspect_relationship** that is an **hvac_branch_connection**, **hvac_plant_-item_connection**, or **hvac_termination_connection**.

WR2: An **hvac_section_segment_termination** is the **related_shape_aspect** in exactly one **shape_-aspect_relationship** that is an **hvac_branch_connection** or an **hvac_plant_item_connection**.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **hvac_section_segment_-termination** entity:

- **application_context_requires_ap_definition** (see 5.2.4.1);
- **dependent_instantiable_application_context** (see 5.2.4.9);
- **dependent_instantiable_product_definition_context** (see 5.2.4.11);
- **product_definition_context_name_constraint** (see 5.2.4.13).

5.2.3.1.52 hvac_system

An **hvac_system** is a type of **product_definition** that identifies a system that is used for heating, ventilation, and air conditioning.

EXPRESS specification:

```
*)
ENTITY hvac_system
  SUBTYPE OF (product_definition);
WHERE
  WR1: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
       ('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF
       (pdr.relating_product_definition.formation.of_product)) AND
       (pdr.relating_product_definition.frame_of_reference.name =
       'functional occurrence'))) = 1;
END_ENTITY;
(*
```

Formal propositions:

WR1: The **hvac_system** shall be related to exactly one **product_definition** that is the definition of a plant and has a context of ‘functional occurrence’.

5.2.3.1.53 hvac_system_section_definition

An **hvac_system_section_definition** is a type of **product_definition** that identifies an HVAC system section.

EXPRESS specification:

```
*)
ENTITY hvac_system_section_definition
  SUBTYPE OF (product_definition);
WHERE
  WR1: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
       ('PLANT_SPATIAL_CONFIGURATION.HVAC_SYSTEM' IN
       TYPEOF (pdr.relating_product_definition)))) = 1;
  WR2: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_DEFINITION_RELATIONSHIP.RELATING_PRODUCT_DEFINITION') |
       'PLANT_SPATIAL_CONFIGURATION.HVAC_SECTION_SEGMENT_DEFINITION' IN
       TYPEOF (pdr.related_product_definition))) >= 1;
  WR3: SELF.frame_of_reference.name =
       'functional definition';
  WR4: SIZEOF (QUERY (pds <* QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
      TYPEOF (pd)) |
      NOT (SIZEOF (QUERY (sa <*USEDIN (pds,
      'PLANT_SPATIAL_CONFIGURATION.SHAPE_ASPECT.OF_SHAPE') |
      ('PLANT_SPATIAL_CONFIGURATION.HVAC_SECTION_SEGMENT_TERMINATION' IN
      TYPEOF (sa)) AND
      (sa.description = 'hvac system section termination'))) <= 2))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: An **hvac_system_section_definition** shall be related to exactly one **hvac_system**.

WR2: An **hvac_system_section_definition** shall be related to at least one **hvac_section_segment_-definition**.

WR3: An **hvac_system_section_definition** shall have an **application_context_element.name** of ‘functional definition’.

WR4: An **hvac_system_section_definition** shall be have at most two related instances of **hvac_section_segment_termination** described as 'hvac system section termination'.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **hvac_system_section_-definition** entity:

- **application_context_requires_ap_definition** (see 5.2.4.1);
- **dependent_instantiable_application_context** (see 5.2.4.9);
- **dependent_instantiable_product_definition_context** (see 5.2.4.11);
- **product_definition_context_name_constraint** (see 5.2.4.13).

5.2.3.1.54 hvac_termination_connection

An **hvac_termination_connection** is a type of **shape_aspect_relationship** that identifies a connection between two HVAC section segment terminations.

EXPRESS specification:

```
*)
ENTITY hvac_termination_connection
  SUBTYPE OF (shape_aspect_relationship);
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.HVAC_SECTION_SEGMENT_TERMINATION'
       IN TYPEOF (SELF.relating_shape_aspect);
  WR2: 'PLANT_SPATIAL_CONFIGURATION.HVAC_SECTION_SEGMENT_TERMINATION'
       IN TYPEOF (SELF.related_shape_aspect);
END_ENTITY;
(*
```

Formal propositions:

WR1: The **relating_shape_aspect** of an **hvac_termination_connection** shall be a an **hvac_section_-segment_termination**.

WR2: The **related_shape_aspect** of an **hvac_termination_connection** shall be a an **hvac_section_-segment_termination**.

5.2.3.1.55 hybrid_shape_representation

A **hybrid_shape_representation** is a type of **shape_representation** that is composed of CSG primitives, boolean operators, manifold solid boundary representation solids, shell based wireframe models, curves and surfaces.

EXPRESS specification:

```
*)
ENTITY hybrid_shape_representation
  SUBTYPE OF (shape_representation);
WHERE
  WR1: SIZEOF (QUERY (i <* SELF\representation.items |
       NOT (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.BOOLEAN_RESULT',
       'PLANT_SPATIAL_CONFIGURATION.CSG_SOLID',
       'PLANT_SPATIAL_CONFIGURATION.RECTANGULAR_PYRAMID',
              'PLANT_SPATIAL_CONFIGURATION.BLOCK',
       'PLANT_SPATIAL_CONFIGURATION.TORUS',
       'PLANT_SPATIAL_CONFIGURATION.RIGHT_CIRCULAR_CYLINDER',
       'PLANT_SPATIAL_CONFIGURATION.SPHERE',
       'PLANT_SPATIAL_CONFIGURATION.RIGHT_CIRCULAR_CONE',
       'PLANT_SPATIAL_CONFIGURATION.EXTRUDED_AREA_SOLID',
       'PLANT_SPATIAL_CONFIGURATION.REVOLVED_AREA_SOLID',
       'PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_3D',
       'PLANT_SPATIAL_CONFIGURATION.MANIFOLD_SOLID_BREP',
       'PLANT_SPATIAL_CONFIGURATION.SHELL_BASED_WIREFRAME_MODEL',
       'PLANT_SPATIAL_CONFIGURATION.CURVE',
       'PLANT_SPATIAL_CONFIGURATION.POINT',
       'PLANT_SPATIAL_CONFIGURATION.SURFACE',
       'PLANT_SPATIAL_CONFIGURATION.VECTOR',
       'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
       'PLANT_SPATIAL_CONFIGURATION.MAPPED_ITEM'] *
       TYPEOF(i)) = 1))) = 0;
  WR2: SIZEOF (QUERY (mi <* QUERY (item <* SELF\representation.items |
       'PLANT_SPATIAL_CONFIGURATION.MAPPED_ITEM' IN TYPEOF(item)) |
       NOT (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.' +
          'PLANT_CSG_SHAPE_REPRESENTATION',
```

```
       'PLANT_SPATIAL_CONFIGURATION.HYBRID_SHAPE_REPRESENTATION'] *
       TYPEOF(mi\mapped_item.mapping_source.mapped_representation))
       = 1))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **hybrid_shape_representation** shall contain **representation_item**s that are of type **boolean_-result**, **csg_solid**, **rectangular_pyramid**, **block**, **torus**, **right_circular_cylinder**, **sphere**, **right_-circular_cone**, **extruded_area_solid**, **revolved_area_solid**, **shell_based_wireframe_model**, **manifold_solid_brep**, **curve**, **point**, **surface**, **vector**, **axis2_placement_3d**, **measure_representation_-item**, or **mapped_item**.

WR2: If there is a **mapped_item** in a **hybrid_shape_representation**, the source of the **mapped_item** shall be a **plant_csg_shape_representation** or a **hybrid_shape_representation**.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **hybrid_shape_representation** entity:

- **subtype_mandatory_shape_representation** (see 5.2.4.18)

5.2.3.1.56 inline_equipment

An **inline_equipment** is a type of **piping_component_definition** that identifies an item that is inserted into the flow of a process stream.

EXPRESS specification:

```
*)
ENTITY inline_equipment
  SUBTYPE OF (piping_component_definition);
END_ENTITY;
(*
```

5.2.3.1.57 instrumentation_and_control_system

An **instrumentation_and_control_system** is a type of **product_definition** that identifies a system of wiring, switches, controls, and other equipment associated with monitoring and controlling performance characteristics.

EXPRESS specification:

```
*)
ENTITY instrumentation_and_control_system
  SUBTYPE OF (product_definition);
WHERE
  WR1: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
       ('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF
       (pdr.relating_product_definition.formation.of_product)) AND
       (pdr.relating_product_definition.frame_of_reference.name =
       'functional occurrence'))) = 1;
END_ENTITY;
(*
```

Formal propositions:

WR1: The **instrumentation_and_control_system** shall be related to exactly one **product_definition** that is the definition of a plant and has a context of ‘functional occurrence’.

5.2.3.1.58 interfering_shape_element

An **interfering_shape_element** identifies a portion of the shape of an item that interferes with the shape of another item.

EXPRESS specification:

```
*)
ENTITY interfering_shape_element
  SUBTYPE OF (shape_aspect, shape_aspect_relationship);
END_ENTITY;
(*
```

5.2.3.1.59 known_source

A **known_source** is a type of **external_source** whose identification is standardized for all implementations of this part of ISO 10303. The purpose of the **known_source** entity data type is to identify particular sources of data that are used within the scope of this part of ISO 10303, and to associate specific data formats with such identification. The following known sources of data are identified in this part of ISO 10303:

- ISO 13584 Dictionaries, conforming to the requirements of ISO 13584-42. In this Part of ISO 10303, such Dictionaries are used to hold values of names for instances of **externally_defined_class**;

- ISO 13584 Parts Libraries, conforming to the requirements of ISO 13584-24. In this Part of ISO 10303, such Parts Libraries are used to hold collections of **catalogue_connector** and **externally_-defined_plant_item_definition**;

EXPRESS specification:

```
*)
ENTITY known_source
  SUBTYPE OF (external_source, pre_defined_item);
WHERE
  WR1: SELF\pre_defined_item.name IN
       ['ISO 13584 Dictionary','ISO 13584 Parts Library'];
END_ENTITY;
(*
```

Formal propositions:

WR1: The **name** of the **known_source** inherited from the **pre_defined_item** shall be ‘ISO 13584 Dictionary’, or ‘ISO 13584 Parts Library’.

Attribute value definitions:

The **known_source** shall be used as follows, based on the standard values of the name attribute.

ISO 13584 Dictionary: the **known_source** shall be a dictionary as defined in ISO 13584-42. The string value given as the **item_id** of an **externally_defined_item** that references this **known_source** shall conform to the requirements for a Class_BSU as defined in ISO 13584-42.

ISO 13584 Parts Library: the **known_source** shall be a parts library as defined in ISO 13584-42. The string value given as the **item_id** of an **externally_defined_item** that references this **known_source** shall conform to the requirements for a BSU as defined in ISO 13584-42.

5.2.3.1.60 line_branch_connection

A **line_branch_connection** is a type of **shape_aspect_relationship** that identifies the connection between a line and a branch.

EXPRESS specification:

```
*)
ENTITY line_branch_connection
  SUBTYPE OF (shape_aspect_relationship);
WHERE
  WR1: SELF.description = 'branch location';
  WR2: 'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_DEFINITION'
       IN TYPEOF (SELF.relating_shape_aspect.of_shape.definition);
  WR3: 'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_TERMINATION'
       IN TYPEOF (SELF.related_shape_aspect);
END_ENTITY;
(*
```

Formal propositions:

WR1: The value of **line_branch_connection.description** shall be ‘branch location’.

WR2: The **product_definition** that the **relating_shape_aspect** of a **line_branch_connection** is related to shall be a **plant_line_segment_definition**.

WR3: The **related_shape_aspect** of a **line_branch_connection** shall be a **plant_line_segment_-termination**.

5.2.3.1.61 line_less_piping_system

A **line_less_piping_system** is a type of **product_definition** that identifies a piping system that is not part of a line.

EXPRESS specification:

```
*)
ENTITY line_less_piping_system
  SUBTYPE OF (product_definition);
END_ENTITY;
(*
```

5.2.3.1.62 line_plant_item_branch_connection

A **line_plant_item_branch_connection** is a type of**shape_aspect_relationship** that identifies the connection between a line and a plant item connector that branches from the line.

EXPRESS specification:

```
*)
ENTITY line_plant_item_branch_connection
  SUBTYPE OF (shape_aspect_relationship);
END_ENTITY;
(*
```

5.2.3.1.63 line_plant_item_connection

A **line_plant_item_ connection** is a type of**shape_aspect_relationship** that identifies the connection between a line segment and a plant item connector.

EXPRESS specification:

```
*)
ENTITY line_plant_item_connection
  SUBTYPE OF (shape_aspect_relationship);
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_TERMINATION'
       IN TYPEOF (SELF.relating_shape_aspect);
  WR2: 'PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR'
       IN TYPEOF (SELF.related_shape_aspect);
  WR3: SELF\shape_aspect_relationship.related_shape_aspect.
       of_shape\property_definition.
       definition\product_definition.
       frame_of_reference\application_context_element.
       name = 'physical occurrence';
END_ENTITY;
(*
```

Formal propositions:

WR1: The **relating_shape_aspect** of a **line_plant_item_connection** shall be a **plant_line_segment_-termination**.

WR2: The **related_shape_aspect** of a **line_plant_item_connection** shall be a **plant_item_connector**.

WR3: The **product_definition** that the **related_shape_aspect** of a **line_plant_item_connection** is related to shall have a context with the name ‘physical occurrence’.

5.2.3.1.64 line_termination_connection

A **line_termination_connection** is a type of **shape_aspect_relationship** that identifies a connection between two line segment terminations, or between a line segment termination and a connection node.

EXPRESS specification:

```
*)
ENTITY line_termination_connection
  SUBTYPE OF (shape_aspect_relationship);
WHERE
  WR1: SIZEOF (TYPEOF (SELF.relating_shape_aspect) *
       ['PLANT_SPATIAL_CONFIGURATION.CONNECTION_NODE',
       'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_TERMINATION']
       ) >= 1;
  WR2: 'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_TERMINATION'
       IN TYPEOF (SELF.related_shape_aspect);
END_ENTITY;
(*
```

Formal propositions:

WR1: The **relating_shape_aspect** of a **line_termination_connection** shall be a **connection_node** or a **plant_line_segment_termination**.

WR2: The **related_shape_aspect** of a **line_termination_connection** shall be a **plant_line_segment_-**

termination.

5.2.3.1.65 pipe_class

A **pipe_class** is a type of **group** that classifies the items that are assigned to it as pipes. The name of the **pipe_class** may further classify the assigned items.

EXPRESS specification:

```
*)
ENTITY pipe_class
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
       'ASSIGNED_CLASS') |
       'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ca)) |
       NOT (SIZEOF (QUERY (it <* aca.items |
       NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)))) = 0))) = 0;
  WR2: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
       'ASSIGNED_CLASS') |
       'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ca)) |
       NOT (SIZEOF (QUERY (pcd <* QUERY (it <* aca.items |
       'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)) |
       NOT (SIZEOF (QUERY (aca1 <* USEDIN (pcd.formation.of_product,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
       class_in_tree (aca1.assigned_class, 'pipe'))) = 1))) = 0))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **pipe_class** shall classify items of type **piping_component_definition**.

WR2: A **pipe_class** shall classify items of type **piping_component_definition** that are a definition of a **product** that is categorized as a ‘pipe’.

5.2.3.1.66 pipe_closure_fitting_class

A **pipe_closure_fitting_class** is a type of **group** that classifies the items that are assigned to it as pipe closure fittings. The name of the **pipe_closure_fitting_class** may further classify the assigned items.

EXPRESS specification:

```
*)
ENTITY pipe_closure_fitting_class
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
       'ASSIGNED_CLASS') |
       'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ca)) |
       NOT (SIZEOF (QUERY (it <* aca.items |
       NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)))) = 0))) = 0;
```

```
  WR2: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
       'ASSIGNED_CLASS') |
       'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ca)) |
       NOT (SIZEOF (QUERY (pcd <* QUERY (it <* aca.items |
       'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)) |
       NOT (SIZEOF (QUERY (aca1 <* USEDIN (pcd.formation.of_product,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
       class_in_tree (aca1.assigned_class, 'pipe closure')))
       = 1))) = 0))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **pipe_closure_fitting_class** shall classify items of type **piping_component_definition**.

WR2: A **pipe_closure_fitting_class** shall classify items of type **piping_component_definition** that are a definition of a **product** that is categorized as a ‘pipe closure’.

5.2.3.1.67 piping_component_class

A **piping_component_class** is a type of **group** that is a **characterized_object** representing a family of piping components defined by parameter range values.

EXPRESS specification:

```
*)
ENTITY piping_component_class
  SUBTYPE OF (group, characterized_object);
END_ENTITY;
(*
```

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **piping_component_class** entity:

- **subtype_exclusive_characterized_object** (see 5.2.4.15)

5.2.3.1.68 piping_component_definition

A **piping_component_definition** is a type of **product_definition** that defines a piping component.

EXPRESS specification:

```
*)
ENTITY piping_component_definition
  SUBTYPE OF (product_definition);
END_ENTITY;
(*
```

5.2.3.1.69 piping_connector_class

A **piping_connector_class** is a type of **group** that classifies the items that are assigned to it as being

piping connectors.

EXPRESS specification:

```
*)
ENTITY piping_connector_class
  SUBTYPE OF (group);
END_ENTITY;
(*
```

5.2.3.1.70 piping_spool_definition

A **piping_spool_definition** is a type of **product_definition** that defines an assembly of **piping_component**s and other **plant_item**s to be fabricated in a shop and physically connected into one item.

NOTE Only welded or screwed **piping_component**s are included in a spool piece

```
*)
ENTITY piping_spool_definition
  SUBTYPE OF (product_definition);
WHERE
  WR1: SIZEOF (USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_DEFINITION_RELATIONSHIP.RELATING_PRODUCT_DEFINITION')) > 1;
END_ENTITY;
(*
```

Formal propositions:

WR1: The **piping_spool_definition** shall relate more than **product_definition**.

5.2.3.1.71 piping_support_definition

A **piping_support_definition** is a type of **product_definition** that defines a piping support.

EXPRESS specification

```
*)
ENTITY piping_support_definition
  SUBTYPE OF (product_definition);
END_ENTITY;
(*
```

5.2.3.1.72 piping_support_fitting_class

A **piping_support_fitting_class** is a type of **group** that classifies the items that are assigned to it as piping support fittings. The name of the **piping_support_fitting_class** may further classify the assigned items.

EXPRESS specification:

```
*)
ENTITY piping_support_fitting_class
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
       'ASSIGNED_CLASS') |
       'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ca)) |
       NOT (SIZEOF (QUERY (it <* aca.items |
```

```
       NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_SUPPORT_DEFINITION' IN
       TYPEOF (it)))) = 0))) = 0;
  WR2: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
       'ASSIGNED_CLASS') |
       'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ca)) |
       NOT (SIZEOF (QUERY (pcd <* QUERY (it <* aca.items |
       'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)) |
       NOT (SIZEOF (QUERY (aca1 <* USEDIN (pcd.formation.of_product,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
       class_in_tree (aca1.assigned_class, 'piping support')))
       = 1))) = 0))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **piping_support_fitting_class** shall classify items of type **piping_component_definition**.

WR2: A **piping_support_fitting_class** shall classify items of type **piping_component_definition** that are a definition of a **product** that is categorized as a ‘piping support’.

5.2.3.1.73 piping_system

A **piping_system** is a type of **product_definition** that identifies a system of interconnected objects that convey fluid, vapour, or particulate flow.

EXPRESS specification:

```
*)
ENTITY piping_system
  SUBTYPE OF (product_definition);
WHERE
  WR1: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
       ('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF
       (pdr.relating_product_definition.formation.of_product)) AND
       (pdr.relating_product_definition.frame_of_reference.name =
       'functional occurrence'))) = 1;
END_ENTITY;
(*
```

Formal propositions:

WR1: The **piping_system** shall be related to exactly one **product_definition** that is the definition of a plant and has a context of ‘functional occurrence’.

5.2.3.1.74 plant

A **plant** is a type of **product** that identifies a process plant facility.

EXPRESS specification:

```
*)
ENTITY plant
  SUBTYPE OF (product);
WHERE
  WR1: SIZEOF (QUERY (pscoa <* USEDIN (SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
```

```
        'PLANT_SPATIAL_CONFIGURATION_ORGANIZATION_ASSIGNMENT.ITEMS')  |
        pscoa.role.name =
        'plant operator')) +
        SIZEOF (QUERY (pscpaoa <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PLANT_SPATIAL_CONFIGURATION_PERSON_AND_ORGANIZATION_ASSIGNMENT.' +
        'ITEMS') |
        pscpaoa.role.name =
        'plant operator')) <= 1;
  WR2: SIZEOF (QUERY (pscoa <* USEDIN(SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PLANT_SPATIAL_CONFIGURATION_ORGANIZATION_ASSIGNMENT.ITEMS') |
        pscoa.role.name = 'plant owner')) +
        SIZEOF (QUERY (pscpaoa <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PLANT_SPATIAL_CONFIGURATION_PERSON_AND_ORGANIZATION_ASSIGNMENT.' +
        'ITEMS') |
        pscpaoa.role.name =
        'plant owner')) +
        SIZEOF (QUERY (pscpa <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PLANT_SPATIAL_CONFIGURATION_PERSON_ASSIGNMENT.ITEMS') |
        pscpa.role.name = 'plant owner')) >= 1;
  WR3: SIZEOF (QUERY (pscoa <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PLANT_SPATIAL_CONFIGURATION_ORGANIZATION_ASSIGNMENT.ITEMS')  |
        pscoa\organization_assignment.role.name =
        'plant project owner')) +
        SIZEOF (QUERY (pscpaoa <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PLANT_SPATIAL_CONFIGURATION_PERSON_AND_ORGANIZATION_ASSIGNMENT.' +
        'ITEMS') |
        pscpaoa\person_and_organization_assignment.role.name =
        'plant project owner')) >= 1;
  WR4:  SIZEOF (QUERY (pdf <* USEDIN (SELF,
         'PLANT_SPATIAL_CONFIGURATION.' +
         'PRODUCT_DEFINITION_FORMATION.OF_PRODUCT') |
         NOT (SIZEOF (QUERY (pd <* USEDIN (pdf,
         'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION.FORMATION') |
         pd.frame_of_reference.name = 'functional occurrence')) <= 1))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **plant** is associated with zero or one **person_and_organization** or **organization** in the role of plant operator.

WR2: A **plant** is associated with at least one **organization**, **person_and_organization**, or **person** in the role of plant owner.

WR3: A **plant** is associated with at least one **person_and_organization** or **organization** in the role of plant project owner.

WR4: A **plant** shall be related to at most one **product_definition** that has a context of ‘functional occurrence’.

Informal proposition:

IP1: If the **plant** has shape, then the **shape_representation** depicting that shape shall have exactly one **axis2_placement_3d** instance in its items set with a name of ‘origin’.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **plant** entity:

- **application_context_requires_ap_definition** (see 5.2.4.1);
- **dependent_instantiable_application_context** (see 5.2.4.9);
- **dependent_instantiable_product_context** (see 5.2.4.10);
- **product_context_discipline_type_constraint** (see 5.2.4.12).

5.2.3.1.75 plant_csg_shape_representation

A **plant_csg_shape_representation** is a type of**shape_representation** that is composed of CSG primitives, revolved solids, extruded solids, and boolean operators.

EXPRESS specification:

```
*)
ENTITY plant_csg_shape_representation
  SUBTYPE OF (shape_representation);
WHERE
  WR1: SIZEOF (QUERY (item <* SELF.items |
       NOT (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.CSG_SOLID',
       'PLANT_SPATIAL_CONFIGURATION.EXTRUDED_AREA_SOLID',
       'PLANT_SPATIAL_CONFIGURATION.REVOLVED_AREA_SOLID',
       'PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_3D',
       'PLANT_SPATIAL_CONFIGURATION.MAPPED_ITEM'] * TYPEOF (item)) = 1)))
       = 0;
  WR2: SIZEOF (QUERY (item <* SELF.items |
       SIZEOF (['PLANT_SPATIAL_CONFIGURATION.CSG_SOLID',
       'PLANT_SPATIAL_CONFIGURATION.EXTRUDED_AREA_SOLID',
       'PLANT_SPATIAL_CONFIGURATION.REVOLVED_AREA_SOLID',
       'PLANT_SPATIAL_CONFIGURATION.MAPPED_ITEM'] * TYPEOF (item))
       = 1)) >= 1;
  WR3: SIZEOF (QUERY (item <* SELF.items |
       ('PLANT_SPATIAL_CONFIGURATION.CSG_SOLID' IN TYPEOF (item)) AND
       (NOT (valid_advanced_csg_tree
                (item\csg_solid.tree_root_expression))))) = 0;
  WR4: SIZEOF (QUERY (mi <* QUERY (item <* SELF.items |
       'PLANT_SPATIAL_CONFIGURATION.MAPPED_ITEM' IN TYPEOF (item)) |
       NOT ('PLANT_SPATIAL_CONFIGURATION.' +
       'PLANT_CSG_SHAPE_REPRESENTATION' IN
       TYPEOF (mi\mapped_item.mapping_source.mapped_representation)))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: Each item of a **plant_csg_shape_representation** shall be a **csg_solid**, **extruded_area_solid**, **revolved_area_solid**, **axis2_placement_3d**, or **mapped_item**.

WR2: A **plant_csg_shape_representation** shall have at least one **representation_item** instance in its set of items that is of type **csg_solid**, **extruded_area_solid**, **revolved_area_solid**, or **mapped_item**.

WR3: A **plant_csg_shape_representation** shall be comprised of the proper CSG tree elements.

WR4: For each **mapped_item** in a **plant_csg_shape_representation**, the source of the **mapped_item** shall be a **plant_csg_shape_representation**.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **plant_csg_shape_-representation** entity:

- **subtype_mandatory_shape_representation** (see 5.2.4.18)

5.2.3.1.76 plant_design_csg_primitive

A **plant_design_csg_primitive** is a type of**solid_model** and a **shape_representation** which specifies a parameterised definition of a constructive solid geometry primitive that is specific to plant design.

NOTE The **plant_design_csg_primitive** is necessary in this part of ISO 10303 to facilitate the representation of CSG primitives specific to plant design CAD systems that were not acceptable as generic CSG primitives within ISO 10303-42.

A **plant_design_csg_primitive** represents one of the following types of CSG primitives specific to plant design:

- hemisphere;
- rectangle to ellipse;
- trimmed sphere;
- trimmed pyramid.

Each type of csg primitive has specific parameters defined for it. The parameters and their requirements are defined in the following clauses.

5.2.3.1.76.1 hemisphere

The hemisphere is a **plant_design_csg_primitive** with a name of 'hemisphere'. It has two parameters: position and radius. The position is defined by an **axis2_placement_3d**. The location attribute of the position specifies the center of the circle formed by the center cut through the sphere upon which the hemisphere is based. The orientation consists of an x,y plane and a z direction. The xy plane specifies the plane in which the center cut circle is defined. The location point shall lie in the xy plane. The z axis direction specifies the direction from the center point which the volume occupies. The radius is defined by a **measure_representation_item** that is also a **length_measure_with_unit**. It specifies the radius of the sphere upon which the hemisphere is based.

5.2.3.1.76.2 rectangle to ellipse

The rectangle to ellipse is a **plant_design_csg_primitive** with a name of 'rectangle to ellipse'. It has eight parameters: position, x size, y size, height, x offset, y offset, semi axis 1, and semi axis 2. The volume is defined by forming transition surfaces between the rectangle defined by x size and y size and the ellipse defined by the semi axis 1 and semi axis 2. The length of the transition is defined by the height. The rectangle to ellipse may be skewed if the x offset or y offset have non-zero values. The base of the volume is a rectangle with its center at the location point of the position. The size of the rectangle is defined by the parameters x size along the X axis and y size along the Y axis. The ellipse is in the plane perpendicular to the Z axis at distance height in the positive Z direction. The center of the ellipse is at x offset, y offset from the intersection point of the Z axis defined by the position and that plane.

The major axis of the ellipse is parallel to the X axis defined by the position, and the minor axis is

parallel to the Y axis defined by the position.

5.2.3.1.76.3 trimmed sphere

The trimmed sphere is a **plant_design_csg_primitive** with a name of ‘trimmed sphere’. It has two parameters: sphere, direction and height. The height varies from -radius to +radius. To place the cutting plane, locate a point along the vector defined by the direction with magnitude of the absolute value of the height coming out of center of the sphere. A cutting plane passes through this point and is perpendicular to the direction. A positive value for the height indicates a trim of the section above the cutting plane. A negative value for the height indicates a trim of the section below the cutting plane.

5.2.3.1.76.4 trimmed pyramid

The trimmed pyramid is a **plant_design_csg_primitive** with a name of ‘trimmed pyramid’. It defines a shape that is a rectangular pyramid that may be skewed. It has eight parameters that define a top and a bottom face, and a height: base position, base length, base width, height, top center x, top center y, top length and top width. The base position is and axis2_placement_3d. The base length an base width define the rectangle that comprises the base of the pyramid with the location point of the base position at the center of the rectangle. The height defines the distance along the z axis at which to place the plane in which the top face of the pyramid is defined. The top center x and top center y parameters define the distance from the point formed by the intersection of the top plane and the z axis of the position at which to place the center of the top face. The top length and top width define the boundaries of the top face of the pyramid.

EXPRESS specification:

```
*)
ENTITY plant_design_csg_primitive
  SUBTYPE OF (shape_representation, solid_model);
WHERE
  WR1: SELF.context_of_items.coordinate_space_dimension = 3;
  WR2: SELF\representation.name = SELF\representation_item.name;
  WR3: SELF\representation.name IN ['hemisphere', 'rectangle to ellipse',
       'trimmed sphere', 'trimmed pyramid'];
  WR4: (NOT (SELF\representation.name = 'hemisphere')) OR
       (SIZEOF (SELF.items) = 2);
  WR5: (NOT (SELF\representation.name = 'hemisphere')) OR
       (SIZEOF (QUERY (it <* SELF.items |
       (it.name = 'position') AND
       ('PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_3D' IN
       TYPEOF (it)))) = 1);
  WR6: (NOT (SELF\representation.name = 'hemisphere')) OR
       (SIZEOF (QUERY (it <* SELF.items |
       (it.name = 'radius') AND
       (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
       'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
       TYPEOF (it)) = 2))) = 1);
  WR7: (NOT (SELF\representation.name = 'rectangle to ellipse')) OR
       (SIZEOF (SELF.items) = 8);
  WR8: (NOT (SELF\representation.name = 'rectangle to ellipse')) OR
       (SIZEOF (QUERY (it <* SELF.items |
       (it.name = 'position') AND
       ('PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_3D' IN
       TYPEOF (it)))) = 1);
  WR9: (NOT (SELF\representation.name = 'rectangle to ellipse')) OR
       (SIZEOF (QUERY (it <* SELF.items |
       (it.name = 'x size') AND
       (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
       'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
       TYPEOF (it)) = 2) AND
       ('PLANT_SPATIAL_CONFIGURATION.POSITIVE_LENGTH_MEASURE' IN
       TYPEOF (it\measure_with_unit.value_component)))) = 1);
 WR10: (NOT (SELF\representation.name = 'rectangle to ellipse')) OR
```

```
      (SIZEOF (QUERY (it <* SELF.items |
      (it.name = 'y size') AND
      (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
      TYPEOF (it)) = 2) AND
      ('PLANT_SPATIAL_CONFIGURATION.POSITIVE_LENGTH_MEASURE' IN
      TYPEOF (it\measure_with_unit.value_component)))) = 1);
WR11: (NOT (SELF\representation.name = 'rectangle to ellipse')) OR
      (SIZEOF (QUERY (it <* SELF.items |
      (it.name = 'height') AND
      (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
      TYPEOF (it)) = 2) AND
      ('PLANT_SPATIAL_CONFIGURATION.POSITIVE_LENGTH_MEASURE' IN
      TYPEOF (it\measure_with_unit.value_component)))) = 1);
WR12: (NOT (SELF\representation.name = 'rectangle to ellipse')) OR
      (SIZEOF (QUERY (it <* SELF.items |
      (it.name = 'x offset') AND
      (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
      TYPEOF (it)) = 2))) = 1);
WR13: (NOT (SELF\representation.name = 'rectangle to ellipse')) OR
      (SIZEOF (QUERY (it <* SELF.items |
      (it.name = 'y offset') AND
      (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
      TYPEOF (it)) = 2))) = 1);
WR14: (NOT (SELF\representation.name = 'rectangle to ellipse')) OR
      (SIZEOF (QUERY (it <* SELF.items |
      (it.name = 'semi axis 1') AND
      (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
      TYPEOF (it)) = 2))) = 1);
WR15: (NOT (SELF\representation.name = 'rectangle to ellipse')) OR
      (SIZEOF (QUERY (it <* SELF.items |
      (it.name = 'semi axis 2') AND
      (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
      TYPEOF (it)) = 2))) = 1);
WR16: (NOT (SELF\representation.name = 'trimmed sphere')) OR
      (SIZEOF (SELF.items) = 3);
WR17: (NOT (SELF\representation.name = 'trimmed sphere')) OR
      (SIZEOF (QUERY (it <* SELF.items |
      (it.name = 'base sphere') AND
      ('PLANT_SPATIAL_CONFIGURATION.SPHERE' IN
      TYPEOF (it)))) = 1);
WR18: (NOT (SELF\representation.name = 'trimmed sphere')) OR
      (SIZEOF (QUERY (it <* SELF.items |
      (it.name = 'cutting plane normal direction') AND
      ('PLANT_SPATIAL_CONFIGURATION.DIRECTION' IN
      TYPEOF (it)))) = 1);
WR19: (NOT (SELF\representation.name = 'trimmed sphere')) OR
      (SIZEOF (QUERY (it <* SELF.items |
      (it.name = 'height') AND
      (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
      TYPEOF (it)) = 2))) = 1);
WR20: (NOT (SELF\representation.name = 'trimmed sphere')) OR
      (SIZEOF (QUERY (ht <* QUERY (it <* SELF.items |
      (it.name = 'height') AND
      (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
      TYPEOF (it)) = 2)) |
      NOT (SIZEOF (QUERY (sphre <* QUERY (it <* SELF.items |
      (it.name = 'base sphere') AND
      ('PLANT_SPATIAL_CONFIGURATION.SPHERE' IN TYPEOF (it))) |
      NOT ({-sphre.radius < ht.value_component < sphre.radius})))
      = 0))) = 0);
WR21: (NOT (SELF\representation.name = 'trimmed pyramid')) OR
      (SIZEOF (SELF.items) = 8);
```

```
 WR22: (NOT (SELF\representation.name = 'trimmed pyramid')) OR
       (SIZEOF (QUERY (it <* SELF.items |
       (it.name = 'base position') AND
       ('PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_3D' IN
       TYPEOF (it)))) = 1);
 WR23: (NOT (SELF\representation.name = 'trimmed pyramid')) OR
       (SIZEOF (QUERY (it <* SELF.items |
       (it.name = 'base length') AND
       (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
       'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
       TYPEOF (it)) = 2))) = 1);
 WR24: (NOT (SELF\representation.name = 'trimmed pyramid')) OR
       (SIZEOF (QUERY (it <* SELF.items |
       (it.name = 'base width') AND
       (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
       'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
       TYPEOF (it)) = 2))) = 1);
 WR25: (NOT (SELF\representation.name = 'trimmed pyramid')) OR
       (SIZEOF (QUERY (it <* SELF.items |
       (it.name = 'height') AND
       (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
       'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
       TYPEOF (it)) = 2))) = 1);
 WR26: (NOT (SELF\representation.name = 'trimmed pyramid')) OR
       (SIZEOF (QUERY (it <* SELF.items |
       (it.name = 'top centre x') AND
       (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
       'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
       TYPEOF (it)) = 2))) = 1);
 WR27: (NOT (SELF\representation.name = 'trimmed pyramid')) OR
       (SIZEOF (QUERY (it <* SELF.items |
       (it.name = 'top centre y') AND
       (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
       'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
       TYPEOF (it)) = 2))) = 1);
 WR28: (NOT (SELF\representation.name = 'trimmed pyramid')) OR
       (SIZEOF (QUERY (it <* SELF.items |
       (it.name = 'top length') AND
       (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
       'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
       TYPEOF (it)) = 2))) = 1);
 WR29: (NOT (SELF\representation.name = 'trimmed pyramid')) OR
       (SIZEOF (QUERY (it <* SELF.items |
       (it.name = 'top width') AND
       (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
       'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
       TYPEOF (it)) = 2))) = 1);
END_ENTITY;
(*
```

Formal propositions:

WR1: The **plant_design_csg_primitive** shall be defined in three dimensions.

WR2: The **plant_design_csg_primitive** shall have a single name. The name attribute shall have the same value for the name attribute of the **representation** and **representation_item**.

WR3: The **plant_design_csg_primitive** shall have a name of either ‘hemisphere’, ‘rectangle to ellipse’, ‘trimmed sphere’, or ‘trimmed pyramid’.

WR4: If the name of the **plant_design_csg_primitive** is ‘hemisphere’, it shall be defined by exactly two representation_items.

WR5: If the name of the **plant_design_csg_primitive** is ‘hemisphere’, exactly one of the **representation_item**s in its definition shall be an **axis2_placement_3d** with a name of ‘position’.

WR6: If the name of the **plant_design_csg_primitive** is ‘hemisphere’, exactly one of the **representation_item**s in its definition shall be a **measure_representation_item** and **length_measure_-with_unit** with a name of ‘radius’.

WR7: If the name of the **plant_design_csg_primitive** is ‘rectangle to ellipse’, it shall be defined by exactly eight representation_items.

WR8: If the name of the **plant_design_csg_primitive** is ‘rectangle to ellipse’, exactly one of the **representation_item**s in its definition shall be an **axis2_placement_3d** with a name of ‘position’.

WR9: If the name of the **plant_design_csg_primitive** is ‘rectangle to ellipse’, exactly one of the **representation_item**s in its definition shall be a **measure_representation_item** and **length_measure_-with_unit** with a name of ‘x size’, the value of which is positive.

WR10: If the name of the **plant_design_csg_primitive** is ‘rectangle to ellipse’, exactly one of the **representation_item**s in its definition shall be a **measure_representation_item** and **length_measure_-with_unit** with a name of ‘y size’, the value of which is positive.

WR11: If the name of the **plant_design_csg_primitive** is ‘rectangle to ellipse’, exactly one of the **representation_item**s in its definition shall be a **measure_representation_item** and **length_measure_-with_unit** with a name of ‘height’, the value of which is positive.

WR12: If the name of the **plant_design_csg_primitive** is ‘rectangle to ellipse’, exactly one of the **representation_item**s in its definition shall be a **measure_representation_item** and **length_measure_-with_unit** with a name of ‘x offset’.

WR13: If the name of the **plant_design_csg_primitive** is ‘rectangle to ellipse’, exactly one of the **representation_item**s in its definition shall be a **measure_representation_item** and **length_measure_-with_unit** with a name of ‘y offset’.

WR14: If the name of the **plant_design_csg_primitive** is ‘rectangle to ellipse’, exactly one of the **representation_item**s in its definition shall be a **measure_representation_item** and **length_measure_-with_unit** with a name of ‘semi axis 1’.

WR15: If the name of the **plant_design_csg_primitive** is ‘rectangle to ellipse’, exactly one of the **representation_item**s in its definition shall be a **measure_representation_item** and **length_measure_-with_unit** with a name of ‘semi axis 2’.

WR16: If the name of the **plant_design_csg_primitive** is ‘trimmed sphere’, it shall be defined by exactly three **representation_item**s.

WR17: If the name of the **plant_design_csg_primitive** is ‘trimmed sphere’, exactly one of the **representation_item**s in its definition shall be a sphere with a name of ‘base sphere’.

WR18: If the name of the **plant_design_csg_primitive** is ‘trimmed sphere’, exactly one of the **representation_item**s in its definition shall be a direction with a name of ‘cutting plane normal direction’.

WR19: If the name of the **plant_design_csg_primitive** is ‘trimmed sphere’, exactly one of the **representation_item**s in its definition shall be a **measure_representation_item** and **length_measure_-with_unit** with a name of ‘radius’.

WR20: If the name of the **plant_design_csg_primitive** is ‘hemisphere’, the value of the height

parameter shall vary between negative radius and positive radius of the sphere.

WR21: If the name of the **plant_design_csg_primitive** is 'trimmed pyramid', it shall be defined by exactly two **representation_item**s.

WR22: If the name of the **plant_design_csg_primitive** is 'trimmed pyramid', exactly one of the **representation_item**s in its definition shall be an axis2_placement_3d with a name of 'base position'.

WR23: If the name of the **plant_design_csg_primitive** is 'trimmed pyramid', exactly one of the **representation_item**s in its definition shall be a **measure_representation_item** and **length_measure_-with_unit** with a name of 'base length'.

WR24: If the name of the **plant_design_csg_primitive** is 'trimmed pyramid', exactly one of the **representation_item**s in its definition shall be a **measure_representation_item** and **length_measure_-with_unit** with a name of 'base width'.

WR25: If the name of the **plant_design_csg_primitive** is 'trimmed pyramid', exactly one of the **representation_item**s in its definition shall be a **measure_representation_item** and **length_measure_-with_unit** with a name of 'height'.

WR26: If the name of the **plant_design_csg_primitive** is 'trimmed pyramid', exactly one of the **representation_item**s in its definition shall be a **measure_representation_item** and **length_measure_-with_unit** with a name of 'top centre x'.

WR27: If the name of the **plant_design_csg_primitive** is 'trimmed pyramid', exactly one of the **representation_item**s in its definition shall be a **measure_representation_item** and **length_measure_-with_unit** with a name of 'top centre y'.

WR28: If the name of the **plant_design_csg_primitive** is 'trimmed pyramid', exactly one of the **representation_item**s in its definition shall be a **measure_representation_item** and **length_measure_-with_unit** with a name of 'top length'.

WR29: If the name of the **plant_design_csg_primitive** is 'trimmed pyramid', exactly one of the **representation_item**s in its definition shall be a **measure_representation_item** and **length_measure_-with_unit** with a name of 'top width'.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **plant_design_csg_primitive** entity:

- **subtype_mandatory_shape_representation** (see 5.2.4.18)

5.2.3.1.77 plant_item_connection

A **plant_item_connection** is a type of **shape_aspect** and **shape_aspect_relationship** that identifies a connection between plant items.

NOTE A connection is a **shape_aspect** of the physical assembly where the two plant items are connected.

EXPRESS specification:

```
*)
ENTITY plant_item_connection
     SUBTYPE OF(shape_aspect, shape_aspect_relationship);
```

```
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR' IN
       TYPEOF (SELF\shape_aspect_relationship.relating_shape_aspect);
  WR2: 'PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR' IN
       TYPEOF (SELF\shape_aspect_relationship.related_shape_aspect);
  WR3: SELF\shape_aspect.of_shape\property_definition.
       definition\product_definition.
       frame_of_reference\application_context_element.name IN
       ['functional occurrence', 'physical occurrence',
       'functional definition', 'physical definition'];
  WR4: (SELF\shape_aspect_relationship.relating_shape_aspect.
       of_shape\property_definition.definition\product_definition.
       frame_of_reference\application_context_element.name =
       SELF\shape_aspect_relationship.related_shape_aspect.
       of_shape\property_definition.definition\product_definition.
       frame_of_reference\application_context_element.name);
  WR5: SIZEOF (USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS')) >= 1;
  WR6: SIZEOF (QUERY (pscca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
       NOT (SIZEOF (
       ['PLANT_SPATIAL_CONFIGURATION.CONNECTION_FUNCTIONAL_CLASS',
       'PLANT_SPATIAL_CONFIGURATION.CONNECTION_MOTION_CLASS'] *
       TYPEOF (pscca.assigned_class)) >= 1))) = 0;
  WR7: SIZEOF (QUERY (pdr <* USEDIN (SELF.of_shape.definition,
       'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_RELATIONSHIP.' +
       'RELATED_PRODUCT_DEFINITION') |
       pdr.name = 'support usage connection')) <= 1;
END_ENTITY;
(*
```

Formal propositions:

WR1: The **relating_shape_aspect** of a **plant_item_connection** shall be a **plant_item_connector**.

WR2: The **related_shape_aspect** of a **plant_item_connection** shall be a **plant_item_connector**.

WR3: The **application_context_element** that applies to a **plant_item_connection** shall have the name ‘functional occurrence’, ‘physical occurrence’, ‘functional definition’, or ‘physical definition’.

WR4: The **application_context_element**s that apply to the **relating_shape_aspect** and the **related_-shape_aspect** of a **plant_item_connection** shall have the same name.

WR5: A **plant_item_connection** shall be classified at least once.

WR6: A **plant_item_connection** shall be classified as a **connection_functional_class**, as a **connection_-motion_class**, or as both.

WR7: The **product_definition** of the **plant_item_connection** shall be the **related_product_definition** in at most one **product_definition_relationship** with a name of ‘support usage connection’.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **plant_item_connection** entity:

- **application_context_requires_ap_definition** (see 5.2.4.1);
- **dependent_instantiable_application_context** (see 5.2.4.9);
- **dependent_instantiable_product_definition_context** (see 5.2.4.11);

- **product_definition_context_name_constraint** (see 5.2.4.13);
- **product_definition_usage_constraint** (see 5.2.4.14).

5.2.3.1.78 plant_item_connector

A **plant_item_connector** is a type of **shape_aspect** that identifies a feature of a plant item that is designed to connect to another connector.

EXPRESS specification:

```
*)
ENTITY plant_item_connector
  SUBTYPE OF(shape_aspect);
WHERE
  WR1: SELF\shape_aspect.of_shape\property_definition.
       definition\product_definition.
       frame_of_reference\application_context_element.name IN
       ['functional definition', 'physical definition',
       'functional occurrence', 'physical occurrence'];
  WR2: SIZEOF (QUERY (pic <*
       (bag_to_set (USEDIN (SELF,'PLANT_SPATIAL_CONFIGURATION.' +
       'SHAPE_ASPECT_RELATIONSHIP.RELATED_SHAPE_ASPECT')) +
       bag_to_set (USEDIN (SELF,'PLANT_SPATIAL_CONFIGURATION.' +
       'SHAPE_ASPECT_RELATIONSHIP.RELATING_SHAPE_ASPECT'))) |
       'PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTION' IN
       TYPEOF (pic))) <= 1;
  WR3: (NOT (SIZEOF (QUERY (aca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
       SIZEOF (TYPEOF (aca.assigned_class) *
       ['PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASS',
       'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASS'])
       = 1)) >= 1)) OR
       ((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
       pd.name = 'service characteristics')) >= 1)) OR
       (SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
       pd.name = 'service characteristics') |
       NOT (SIZEOF (QUERY (pdr <* USEDIN (sc,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name =
       'design service characteristics')) = 1))) = 0));
  WR4: (NOT (SIZEOF (QUERY (aca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
       SIZEOF (TYPEOF (aca.assigned_class) *
       ['PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASS',
       'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASS'])
       = 1)) >= 1)) OR
       (NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
       (pd.name = 'service characteristics') )) >= 1)) OR
       (SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
       pd.name = 'service characteristics') |
       NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = 'design service characteristics') |
       SIZEOF (dsc.used_representation.items) >= 2)) = 1))) = 0);
  WR5: (NOT (SIZEOF (QUERY (aca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
          SIZEOF (TYPEOF (aca.assigned_class) *
```

```
     ['PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASS',
     'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASS'])
     = 1)) >= 1)) OR
     ((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
     'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
     pd.name = 'service characteristics')) >= 1)) OR
     (SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
     'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
     pd.name = 'service characteristics') |
     NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
     'PLANT_SPATIAL_CONFIGURATION.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     pdr.used_representation.name = 'design service characteristics') |
     {1 <= SIZEOF (QUERY (it <* dsc.used_representation.items |
     ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
     TYPEOF (it)) AND
     (it.name IN ['pressure', 'minimum pressure',
     'maximum pressure'])))  <= 2})) = 1))) = 0));
WR6: (NOT (SIZEOF (QUERY (aca <* USEDIN (SELF,
     'PLANT_SPATIAL_CONFIGURATION.' +
     'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
     SIZEOF (TYPEOF (aca.assigned_class) *
     ['PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASS',
     'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASS'])
     = 1)) >= 1)) OR
     ((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
     'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
     pd.name = 'service characteristics')) >= 1)) OR
     (SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
     'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
     pd.name = 'service characteristics') |
     NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
     'PLANT_SPATIAL_CONFIGURATION.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     pdr.used_representation.name = 'design service characteristics') |
     SIZEOF (QUERY (it <* dsc.used_representation.items |
     ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
     TYPEOF (it)) AND
     (it.name = 'pressure'))) <= 1)) = 1))) = 0));
WR7: (NOT (SIZEOF (QUERY (aca <* USEDIN (SELF,
     'PLANT_SPATIAL_CONFIGURATION.' +
     'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
     SIZEOF (TYPEOF (aca.assigned_class) *
     ['PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASS',
     'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASS'])
     = 1)) >= 1)) OR
     ((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
     'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
     pd.name = 'service characteristics')) >= 1)) OR
     (SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
     'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
     pd.name = 'service characteristics') |
     NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
     'PLANT_SPATIAL_CONFIGURATION.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     pdr.used_representation.name = 'design service characteristics') |
     SIZEOF (QUERY (it <* dsc.used_representation.items |
     ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
     TYPEOF (it)) AND
     (it.name = 'minimum pressure'))) <= 1)) = 1))) = 0));
WR8: (NOT (SIZEOF (QUERY (aca <* USEDIN (SELF,
     'PLANT_SPATIAL_CONFIGURATION.' +
     'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
     SIZEOF (TYPEOF (aca.assigned_class) *
     ['PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASS',
     'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASS'])
     = 1)) >= 1)) OR
     ((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
     'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
     pd.name = 'service characteristics')) >= 1)) OR
```

```
      (SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      pd.name = 'service characteristics') |
      NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'design service characteristics') |
      SIZEOF (QUERY (it <* dsc.used_representation.items |
      ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
      TYPEOF (it)) AND
      (it.name = 'maximum pressure'))) <= 1)) = 1))) = 0));
 WR9: (NOT (SIZEOF (QUERY (aca <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
      SIZEOF (TYPEOF (aca.assigned_class) *
      ['PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASS',
      'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASS'])
      = 1)) >= 1)) OR
      ((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      pd.name = 'service characteristics')) >= 1)) OR
      (SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      pd.name = 'service characteristics') |
      NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'design service characteristics') |
      {1 <= SIZEOF (QUERY (it <* dsc.used_representation.items |
      (SIZEOF (TYPEOF (it) *
      ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.' +
      'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
      (it.name IN ['temperature', 'minimum temperature',
      'maximum temperature'])))) <= 2})) = 1))) = 0));
WR10: (NOT (SIZEOF (QUERY (aca <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
      SIZEOF (TYPEOF (aca.assigned_class) *
      ['PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASS',
      'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASS'])
      = 1)) >= 1)) OR
      ((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      pd.name = 'service characteristics')) >= 1)) OR
      (SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      pd.name = 'service characteristics') |
      NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'design service characteristics') |
      SIZEOF (QUERY (it <* dsc.used_representation.items |
      (SIZEOF (TYPEOF (it) *
      ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.' +
      'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
      (it.name = 'temperature'))) <= 1)) = 1))) = 0));
WR11: (NOT (SIZEOF (QUERY (aca <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
      SIZEOF (TYPEOF (aca.assigned_class) *
      ['PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASS',
      'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASS'])
      = 1)) >= 1)) OR
      ((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      pd.name = 'service characteristics')) >= 1)) OR
      (SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
```

```
       pd.name = 'service characteristics') |
       NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = 'design service characteristics') |
       SIZEOF (QUERY (it <* dsc.used_representation.items |
       (SIZEOF (TYPEOF (it) *
       ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
       'PLANT_SPATIAL_CONFIGURATION.' +
       'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
       (it.name = 'minimum temperature'))) <= 1)) = 1))) = 0));
 WR12: (NOT (SIZEOF (QUERY (aca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
       SIZEOF (TYPEOF (aca.assigned_class) *
       ['PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASS',
       'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASS'])
       = 1)) >= 1)) OR
       ((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
       pd.name = 'service characteristics')) >= 1)) OR
       (SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
       pd.name = 'service characteristics') |
       NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = 'design service characteristics') |
       SIZEOF (QUERY (it <* dsc.used_representation.items |
       (SIZEOF (TYPEOF (it) *
       ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
       'PLANT_SPATIAL_CONFIGURATION.' +
       'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
       (it.name = 'maximum temperature'))) <= 1)) = 1))) = 0));
 WR13: (NOT (SELF\shape_aspect.of_shape\property_definition.
       definition\product_definition.
       frame_of_reference\application_context_element.name IN
       ['functional definition', 'functional occurrence'])) OR
       (SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       'PLANT_SPATIAL_CONFIGURATION.SHAPE_REPRESENTATION' IN
       TYPEOF (pdr.used_representation))) = 0);
END_ENTITY;
(*
```

Formal propositions:

WR1: The **application_context_element** that applies to a **plant_item_connector** (as its **product_-definition_context**) shall have the name ‘functional definition’, ‘physical definition’ ‘functional occurrence’, or ‘physical occurrence’.

WR2: The **plant_item_connector** shall be the connector in at most one **plant_item_connection**.

WR3: If the **plant_item_connector** is classified as either a piping connector or a connector end type and has a **property_definition** with a name of ‘service characteristics’, the **property_definition** shall have exactly one **representation** with the name of ‘design service characteristics’.

WR4: If the **plant_item_connector** is classified as either a piping connector or a connector end type and has a **property_definition** with a name of ‘service characteristics’, the **property_definition** shall have exactly one **representation** with a name of ‘design service characteristics’ that has at least two **representation_item**s.

WR5: If the **plant_item_connector** is classified as either a piping connector or a connector end type and has a **property_definition** with a name of ‘service characteristics’, the **property_definition** shall have

exactly one **representation** with a name of ‘design service characteristics’ that has one or two **representation_item**s of type **measure_representation_item** with a name of ‘pressure’, ‘minimum pressure’, or ‘maximum pressure’.

WR6: If the **plant_item_connector** is classified as either a piping connector or a connector end type and has a **property_definition** with a name of ‘service characteristics’, the **property_definition** shall have exactly one **representation** with a name of ‘design service characteristics’ that has at most one **representation_item** of type measure_representation_item with a name of ‘pressure’.

WR7: If the **plant_item_connector** is classified as either a piping connector or a connector end type and has a **property_definition** with a name of ‘service characteristics’, the **property_definition** shall have exactly one **representation** with a name of ‘design service characteristics’ that has at most one **representation_item** of type **measure_representation_item** with a name of ‘minimum pressure’.

WR8: If the **plant_item_connector** is classified as either a piping connector or a connector end type and has a **property_definition** with a name of ‘service characteristics’, the **property_definition** shall have exactly one **representation** with a name of ‘design service characteristics’ that has at most one **representation_item** of type **measure_representation_item** with a name of ‘maximum pressure’.

WR9: If the **plant_item_connector** is classified as either a piping connector or a connector end type and has a **property_definition** with a name of ‘service characteristics’, the **property_definition** shall have exactly one **representation** with a name of ‘design service characteristics’ that has one or two **representation_item**s of type **measure_representation_item** and **thermodynamic_temperature_-measure_with_unit** with a name of ‘temperature’, ‘minimum temperature’, or ‘maximum temperature’.

WR10: If the **plant_item_connector** is classified as either a piping connector or a connector end type and has a **property_definition** with a **name** of ‘service characteristics’, the **property_definition** shall have exactly one **representation** with a **name** of ‘design service characteristics’ that has at most one **representation_item** of type **measure_representation_item** and **thermodynamic_temperature_-measure_with_unit** with a **name** of ‘temperature’.

WR11: If the **plant_item_connector** is classified as either a piping connector or a connector end type and has a **property_definition** with a **name** of ‘service characteristics’, the **property_definition** shall have exactly one **representation** with a **name** of ‘design service characteristics’ that has at most one **representation_item** of type **measure_representation_item** and **thermodynamic_temperature_-measure_with_unit** with a **name** of ‘minimum temperature’.

WR12: If the **plant_item_connector** is classified as either a piping connector or a connector end type and has a **property_definition** with a **name** of ‘service characteristics’, the **property_definition** shall have exactly one **representation** with a **name** of ‘design service characteristics’ that has at most one **representation_item** of type **measure_representation_item** and **thermodynamic_temperature_-measure_with_unit** with a **name** of ‘maximum temperature’.

WR13: If a **plant_item_connector** is a functional connector it shall not have any **shape_representation**.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **plant_item_connector** entity:

- **application_context_requires_ap_definition** (see 5.2.4.1);
- **dependent_instantiable_application_context** (see 5.2.4.9);

- **dependent_instantiable_product_definition_context** (see 5.2.4.11);
- **product_definition_context_name_constraint** (see 5.2.4.13);
- **product_definition_usage_constraint** (see 5.2.4.14).

5.2.3.1.79 plant_item_interference

A **plant_item_interference** is a type of **product_definition_relationship** that identifies interference between plant items.

EXPRESS specification:

```
*)
ENTITY plant_item_interference
  SUBTYPE OF (product_definition_relationship);
END_ENTITY;
(*
```

5.2.3.1.80 plant_item_route

A **plant_item_route** is a type of **product_definition_shape** that identifies the 3D path of a **plant_line_-definition** or a **plant_line_segment_definition**.

EXPRESS specification:

```
*)
ENTITY plant_item_route
  SUBTYPE OF (product_definition_shape);
WHERE
  WR1: SELF\property_definition.definition\product_definition.
       frame_of_reference\application_context_element.name =
       'physical occurrence';
  WR2: SIZEOF (TYPEOF (SELF\property_definition.definition) *
       ['PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_DEFINITION',
       'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_DEFINITION']) = 1;
END_ENTITY;
(*
```

Formal propositions:

WR1: The **name** of the **product_definition_context** that a **plant_item_route** is related to shall be ‘physical occurrence’.

WR2: A **plant_item_route** shall be the definition of the shape of a **plant_line_definition** or a **plant_-line_segment_definition**.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **plant_item_route** entity:

- **application_context_requires_ap_definition** (see 5.2.4.1);
- **dependent_instantiable_application_context** (see 5.2.4.9);
- **dependent_instantiable_product_definition_context** (see 5.2.4.11);

- **product_definition_context_name_constraint** (see 5.2.4.13);
- **product_definition_usage_constraint** (see 5.2.4.14).

5.2.3.1.81 plant_item_weight_representation

A **plant_item_weight_representation** is a type of **property_definition_representation** that specifies the weight of plant items.

EXPRESS specification:

```
*)
ENTITY plant_item_weight_representation
  SUBTYPE OF (property_definition_representation);
WHERE
  WR1: SELF.used_representation.name = 'item weight';
  WR2: SIZEOF (SELF.used_representation.items) >= 2;
  WR3: SIZEOF (QUERY (it <* SELF.used_representation.items |
       (it.name IN ['weight value',
       'maximum weight value', 'minimum weight value']) AND
       (NOT (SIZEOF (TYPEOF (it) *
       ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
       'PLANT_SPATIAL_CONFIGURATION.QUALIFIED_REPRESENTATION_ITEM']) =
       2)))) = 0;
  WR4: SIZEOF (QUERY (it <* SELF.used_representation.items |
       ('PLANT_SPATIAL_CONFIGURATION.GEOMETRIC_REPRESENTATION_ITEM'
       IN TYPEOF (it)) AND
       (it.name = 'centre of gravity'))) = 1;
  WR5: {1 <= SIZEOF (QUERY (it <* SELF.used_representation.items |
       it.name IN ['weight value',
       'maximum weight value', 'minimum weight value'])) <= 2};
  WR6: SIZEOF (QUERY (it <* SELF\property_definition_representation.
       used_representation.items |
       (it.name IN ['maximum weight value', 'minimum weight value']) AND

       (NOT (SIZEOF (QUERY (tq <* QUERY (qual <*
       it\qualified_representation_item.qualifiers |
       'PLANT_SPATIAL_CONFIGURATION.TYPE_QUALIFIER' IN TYPEOF (qual)) |
       tq.name = 'operating')) = 1)))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: The name of the **plant_item_weight_representation** shall be ‘item weight’.

WR2: The **plant_item_weight_representation** shall contain at least two items.

WR3: If the **plant_item_weight_representation** contains a **representation_item** with a name of ‘weight value’, ‘maximum weight value’, or ‘minimum weight value’, the **representation_item** shall be a **measure_representation_item** and a **qualified_representation_item**.

WR4: The **plant_item_weight_representation** shall contain exactly one **representation_item** that is a **geometric_representation_item** with a name of ‘centre of gravity’.

WR5: The **plant_item_weight_representation** shall have between 1 and 2 **representation_items** with a **name** of ‘weight value’, ‘maximum weight value’, or ‘minimum weight value’.

WR6: If the **plant_item_weight_representation** has a **representation_item** with a **name** of ‘maximum weight value’ or ‘minimum weight value’, the **representation_item** shall have a **type_qualifier** with a

name of ‘operating’.

5.2.3.1.82 plant_line_definition

A **plant_line_definition** is a type of **product_definition_with_associated_documents** that identifies a piping system line.

EXPRESS specification:

```
*)
ENTITY plant_line_definition
  SUBTYPE OF (product_definition_with_associated_documents);
WHERE
  WR1: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
       ('PLANT_SPATIAL_CONFIGURATION.PIPING_SYSTEM' IN
       TYPEOF (pdr.relating_product_definition)))) = 1;
  WR2: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_DEFINITION_RELATIONSHIP.RELATING_PRODUCT_DEFINITION') |
       'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_DEFINITION' IN
       TYPEOF (pdr.related_product_definition))) >= 1;
  WR3: (NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
       SIZEOF (USEDIN (pd, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) >= 1)) = 0))  OR
       (SIZEOF (QUERY (pd <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
       NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       SIZEOF (QUERY (rep <*
       USEDIN (pdr.used_representation.context_of_items,
       'PLANT_SPATIAL_CONFIGURATION.REPRESENTATION.CONTEXT_OF_ITEMS') |
       SIZEOF (QUERY (prop_def_rep <* USEDIN (rep,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.USED_REPRESENTATION') |
       (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.SITE',
       'PLANT_SPATIAL_CONFIGURATION.SITE_BUILDING'] *
       TYPEOF (prop_def_rep.definition)) = 1) OR
       ('PLANT_SPATIAL_CONFIGURATION.PLANT' IN
       TYPEOF (prop_def_rep.definition.definition.formation.of_product))))
       >= 1)) >= 1)) >= 1))) = 0);
  WR4: SELF.frame_of_reference.name =
       'functional definition';
  WR5: SIZEOF (QUERY (pds <* QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
      TYPEOF (pd)) |
      NOT (SIZEOF (QUERY (sa <*USEDIN (pds,
      'PLANT_SPATIAL_CONFIGURATION.SHAPE_ASPECT.OF_SHAPE') |
      ('PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_TERMINATION' IN
      TYPEOF (sa)) AND
      (sa.description = 'piping line termination'))) <= 2))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **plant_line_definition** shall be related to exactly one **piping_system**.

WR2: A **plant_line_definition** shall be related to at least one **plant_line_segment_definition**.

WR3: If a **plant_line_definition** has a representation, that representation shall be in the context of a **site_building**, a **site**, or a **plant**.

WR4: A **plant_line_definition** shall have an **application_context_element.name** of 'functional definition'.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **plant_line_definition** entity:

- **application_context_requires_ap_definition** (see 5.2.4.1);
- **dependent_instantiable_application_context** (see 5.2.4.9);
- **dependent_instantiable_product_definition_context** (see 5.2.4.11);
- **product_definition_context_name_constraint** (see 5.2.4.13).

5.2.3.1.83 plant_line_segment_definition

A **plant_line_segment_definition** is a type of **product_definition** that identifies a line segment.

EXPRESS specification:

```
*)
ENTITY plant_line_segment_definition
  SUBTYPE OF (product_definition);
WHERE
  WR1: SIZEOF (QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
       'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_DEFINITION'
       IN TYPEOF (pdr.relating_product_definition))) >= 1;
  WR2: SIZEOF (QUERY( pd <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
       'PLANT_SPATIAL_CONFIGURATION.SHAPE_DEFINITION' IN
       TYPEOF (pd))) >= 1;
  WR3: SELF.frame_of_reference\application_context_element.name =
       'functional definition';
  WR4: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = 'line segment characteristics')) = 1;
  WR5: SIZEOF (QUERY (lsc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = 'line segment characteristics') |
       NOT (SIZEOF (lsc.used_representation.items) >= 2))) = 0;
  WR6: SIZEOF (QUERY (lsc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = 'line segment characteristics') |
       NOT (SIZEOF (QUERY (it <* lsc.used_representation.items |
       ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
       TYPEOF (it)) AND
       (it.name = 'design pressure'))) = 1))) = 0;
  WR7: SIZEOF (QUERY (lsc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = 'line segment characteristics') |
       NOT (SIZEOF (QUERY (it <* lsc.used_representation.items |
       (SIZEOF (TYPEOF (it) *
       ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
       'PLANT_SPATIAL_CONFIGURATION.' +
       'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
       (it.name = 'design temperature'))) = 1))) = 0;
  WR8: SIZEOF (QUERY (lsc <* QUERY (pdr <* USEDIN (SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
```

```
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'line segment characteristics') |
      NOT (SIZEOF (QUERY (it <* lsc.used_representation.items |
      (SIZEOF (TYPEOF (it) *
      ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']) = 2) AND
      (it.name = 'elevation'))) <= 1))) = 0;
 WR9: SIZEOF (QUERY (lsc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'line segment characteristics') |
      NOT (SIZEOF (QUERY (it <* lsc.used_representation.items |
      ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
      TYPEOF (it)) AND
      (it.name = 'corrosion allowance'))) <= 1))) = 0;
WR10: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
      pdr.name = 'segment insulation')) >= 1)) OR
      (SIZEOF (QUERY (si <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
      pdr.name = 'segment insulation') |
      NOT (SIZEOF (QUERY (pd <* USEDIN (si,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      NOT (SIZEOF (QUERY (pds <* QUERY (pdr <* USEDIN (pd,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
      TYPEOF (pdr)) |
      pds.used_representation.name =
      'segment insulation characteristics')) = 1))) = 0))) = 0);
WR11: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
      pdr.name = 'segment insulation')) >= 1)) OR
      (SIZEOF (QUERY (si <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
      pdr.name = 'segment insulation') |
      NOT (SIZEOF (QUERY (pd <* USEDIN (si,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      NOT (SIZEOF (QUERY (sic <* QUERY (pds <* QUERY (pdr <* USEDIN (pd,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
      TYPEOF (pdr)) |
      pds.used_representation.name =
      'segment insulation characteristics') |
      SIZEOF (sic.used_representation.items) >= 1)) = 1))) = 0))) = 0);
WR12: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
      pdr.name = 'segment insulation')) >= 1)) OR
      (SIZEOF (QUERY (si <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
      pdr.name = 'segment insulation') |
      NOT (SIZEOF (QUERY (pd <* USEDIN (si,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      NOT (SIZEOF (QUERY (sic <* QUERY (pds <* QUERY (pdr <* USEDIN (pd,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
      TYPEOF (pdr)) |
      pds.used_representation.name =
      'segment insulation characteristics') |
      {1 <= SIZEOF (QUERY (it <* sic.used_representation.items |
      (SIZEOF (TYPEOF (it) *
      ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
```

```
      'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']) = 2) AND
      (it.name IN ['thickness', 'minimum thickness',
      'maximum thickness']))) <= 2})) = 1))) = 0))) = 0);
WR13: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
      pdr.name = 'segment insulation')) >= 1)) OR
      (SIZEOF (QUERY (si <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
      pdr.name = 'segment insulation') |
      NOT (SIZEOF (QUERY (pd <* USEDIN (si,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      NOT (SIZEOF (QUERY (sic <* QUERY (pds <* QUERY (pdr <* USEDIN (pd,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
      TYPEOF (pdr)) |
      pds.used_representation.name =
      'segment insulation characteristics') |
      SIZEOF (QUERY (it <* sic.used_representation.items |
      (SIZEOF (TYPEOF (it) *
      ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']) = 2) AND
      (it.name = 'thickness'))) <= 1)) = 1))) = 0))) = 0);
WR14: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
      pdr.name = 'segment insulation')) >= 1)) OR
      (SIZEOF (QUERY (si <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
      pdr.name = 'segment insulation') |
      NOT (SIZEOF (QUERY (pd <* USEDIN (si,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      NOT (SIZEOF (QUERY (sic <* QUERY (pds <* QUERY (pdr <* USEDIN (pd,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
      TYPEOF (pdr)) |
      pds.used_representation.name =
      'segment insulation characteristics') |
      SIZEOF (QUERY (it <* sic.used_representation.items |
      (SIZEOF (TYPEOF (it) *
      ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']) = 2) AND
      (it.name = 'minimum thickness'))) <= 1)) = 1))) = 0))) = 0);
WR15: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
      pdr.name = 'segment insulation')) >= 1)) OR
      (SIZEOF (QUERY (si <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
      pdr.name = 'segment insulation') |
      NOT (SIZEOF (QUERY (pd <* USEDIN (si,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      NOT (SIZEOF (QUERY (sic <* QUERY (pds <* QUERY (pdr <* USEDIN (pd,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
      TYPEOF (pdr)) |
      pds.used_representation.name =
      'segment insulation characteristics') |
      SIZEOF (QUERY (it <* sic.used_representation.items |
      (SIZEOF (TYPEOF (it) *
      ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']) = 2) AND
      (it.name = 'maximum thickness'))) <= 1)) = 1))) = 0))) = 0);
WR16: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
```

```
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
       pdr.name = 'segment insulation')) >= 1)) OR
       (SIZEOF (QUERY (si <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
       pdr.name = 'segment insulation') |
       NOT (SIZEOF (QUERY (pd <* USEDIN (si,
       'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
       NOT (SIZEOF (QUERY (sic <* QUERY (pds <* QUERY (pdr <* USEDIN (pd,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
       TYPEOF (pdr)) |
       pds.used_representation.name =
       'segment insulation characteristics') |
       SIZEOF (QUERY (it <* sic.used_representation.items |
       ('PLANT_SPATIAL_CONFIGURATION.DESCRIPTIVE_REPRESENTATION_ITEM' IN
       TYPEOF (it)) AND
       (it.name = 'boundaries'))) <= 1)) = 1))) = 0))) = 0);
WR17: SIZEOF (QUERY (pds <* QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
      TYPEOF (pd)) |
      NOT (SIZEOF (QUERY (sa <*USEDIN (pds,
      'PLANT_SPATIAL_CONFIGURATION.SHAPE_ASPECT.OF_SHAPE') |
      'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_TERMINATION' IN
      TYPEOF (sa))) = 2))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **plant_line_segment_definition** shall be the **related_product_definition** in a **product_-definition_relationship** that has a **relating_product_definition** that is a **plant_line_definition**.

WR2: A **plant_line_segment_definition** shall be referenced by a **shape_definition**.

WR3: A **plant_line_segment_definition** shall have a **frame_of_reference name** of ‘functional definition’.

WR4: A **plant_line_segment_definition** shall have exactly one representation with the name of ‘line segment characteristics’.

WR5: The representation of the **plant_line_segment_definition** with the name of ‘line segment characteristics’ shall have at least two **representation_item**s.

WR6: The representation of the **plant_line_segment_definition** with the name of ‘line segment characteristics’ shall have exactly one **representation_item** that is of type **measure_representation_-item** with a name of ‘design pressure’.

WR7: The representation of the **plant_line_segment_definition** with the name of ‘line segment characteristics’ shall have exactly one **representation_item** that is of type **measure_representation_-item** and **thermodynamic_temperature_measure_with_unit** with a name of ‘design temperature’.

WR8: The representation of the **plant_line_segment_definition** with the name of ‘line segment characteristics’ shall have at most one **representation_item** that is of type **measure_representation_-item** and **length_measure_with_unit** with a name of ‘elevation’.

WR9: The representation of the **plant_line_segment_definition** with the name of ‘line segment characteristics’ shall have at most one **representation_item** that is of type **measure_representation_-**

item with a name of ‘corrosion allowance’.

WR10: If the **plant_line_segment_definition** is related to a **product_definition** as a ‘segment insulation’, the **product_definition** shall have a **product_definition_shape** that has exactly one **representation** with the **name** of ‘segment insulation characteristics’.

WR11: If the **plant_line_segment_definition** is related to a **product_definition** as a ‘segment insulation’, the **product_definition** shall have a **product_definition_shape** that has exactly one **representation** with the **name** of ‘segment insulation characteristics’ that has at least one **representation_item**.

WR12: If the **plant_line_segment_definition** is related to a **product_definition** as a ‘segment insulation’, the **product_definition** shall have a **product_definition_shape** that has exactly one **representation** with the **name** of ‘segment insulation characteristics’ that has one or two **representation_item**s of type **measure_representation_item** and **length_measure_with_unit** with a **name** of ‘thickness’, ‘minimum thickness’, or ‘maximum thickness’.

WR13: If the **plant_line_segment_definition** is related to a **product_definition** as a ‘segment insulation’, the **product_definition** shall have a **product_definition_shape** that has exactly one **representation** with the **name** of ‘segment insulation characteristics’ that has at most one **representation_item** items of type **measure_representation_item** and **length_measure_with_unit** with a **name** of ‘thickness’.

WR14: If the **plant_line_segment_definition** is related to a **product_definition** as a ‘segment insulation’, the **product_definition** shall have a **product_definition_shape** that has exactly one **representation** with the **name** of ‘segment insulation characteristics’ that has at most one **representation_item** items of type **measure_representation_item** and **length_measure_with_unit** with a **name** of ‘minimum thickness’.

WR15: If the **plant_line_segment_definition** is related to a **product_definition** as a ‘segment insulation’, the **product_definition** shall have a **product_definition_shape** that has exactly one **representation** with the **name** of ‘segment insulation characteristics’ that has at most one **representation_item** items of type **measure_representation_item** and **length_measure_with_unit** with a **name** of ‘maximum thickness’.

WR16: If the **plant_line_segment_definition** is related to a **product_definition** as a ‘segment insulation’, the **product_definition** shall have a **product_definition_shape** that has exactly one **representation** with the **name** of ‘segment insulation characteristics’ that has at most one **representation_item** items of type **descriptive_representation_item** with a **name** of ‘boundaries’.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **plant_line_segment_definition** entity:

- **application_context_requires_ap_definition** (see 5.2.4.1);
- **dependent_instantiable_application_context** (see 5.2.4.9);
- **dependent_instantiable_product_definition_context** (see 5.2.4.11);
- **product_definition_context_name_constraint** (see 5.2.4.13).

5.2.3.1.84 plant_line_segment_termination

A **plant_line_segment_termination** is a type of **shape_aspect** that identifies the termination of a line segment.

EXPRESS specification:

```
*)
ENTITY plant_line_segment_termination
  SUBTYPE OF (shape_aspect);
WHERE
  WR1: ((SELF.description = 'piping line segment termination') AND
       ('PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_DEFINITION'
       IN TYPEOF (SELF.of_shape.definition))) XOR
       ((SELF.description = 'piping line termination') AND
       ('PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_RELATIONSHIP'
       IN TYPEOF (SELF.of_shape.definition)) AND
       ('PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_DEFINITION'
       IN TYPEOF (SELF.of_shape.definition.related_product_definition)) AND
       ('PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_DEFINITION'
       IN TYPEOF (SELF.of_shape.definition.relating_product_definition)));
  WR2: SIZEOF (QUERY (sar <*
       USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'SHAPE_ASPECT_RELATIONSHIP.RELATING_SHAPE_ASPECT') +
       USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'SHAPE_ASPECT_RELATIONSHIP.RELATED_SHAPE_ASPECT') |
       NOT (SIZEOF (TYPEOF (sar) *
       ['PLANT_SPATIAL_CONFIGURATION.LINE_BRANCH_CONNECTION',
       'PLANT_SPATIAL_CONFIGURATION.LINE_PLANT_ITEM_CONNECTION',
       'PLANT_SPATIAL_CONFIGURATION.LINE_TERMINATION_CONNECTION'])
       = 1))) = 0;
  WR3: SIZEOF (QUERY (sar <*
       USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.'+
       'SHAPE_ASPECT_RELATIONSHIP.RELATED_SHAPE_ASPECT') |
       SIZEOF (TYPEOF (sar) *
       ['PLANT_SPATIAL_CONFIGURATION.LINE_BRANCH_CONNECTION',
       'PLANT_SPATIAL_CONFIGURATION.LINE_PLANT_ITEM_CONNECTION']) = 1))= 1;
END_ENTITY;
(*
```

Formal propositions:

WR1: If a **plant_line_segment_termination** is the termination of a piping line segment, it shall be an aspect of the shape of a **plant_line_segment_definition**. If the **plant_line_segment_termination** is the termination of a piping line, it shall be an aspect of the shape of a **product_definition_relationship** in which the related_product_definition is a **plant_line_segment_definition** and the relating_shape_aspect is a **plant_line_definition**.

WR2: A **plant_line_segment_termination** is the **relating_shape_aspect** or the **related_shape_aspect** in at least one **shape_aspect_relationship** that is a **line_branch_connection**, **line_plant_item_-connection**, or **line_termination_connection**.

WR3: A **plant_line_segment_termination** is the related_shape_aspect in exactly one **shape_aspect_-relationship** that is either a **line_termination_connection** or **line_branch_connection** or is the relating_shape_aspect in exactly one **line_plant_item_connection** .

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **plant_line_segment_-termination** entity:

- **application_context_requires_ap_definition** (see 5.2.4.1);
- **dependent_instantiable_application_context** (see 5.2.4.9);
- **dependent_instantiable_product_definition_context** (see 5.2.4.11);
- **product_definition_context_name_constraint** (see 5.2.4.13).

5.2.3.1.85 plant_spatial_configuration_change_assignment

A **plant_spatial_configuration_change_assignment** assigns a **change_action** to a set of one or more **change_item**s.

EXPRESS specification:

```
*)
ENTITY plant_spatial_configuration_change_assignment
  SUBTYPE OF (action_assignment);
  items : SET [1:?] OF change_item;
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.CHANGE_ACTION'
       IN TYPEOF (SELF.assigned_action);
END_ENTITY;
(*
```

Attribute definitions:

items: the set of **change_item**s that an action is assigned to.

Formal propositions:

WR1: The assigned action shall be a **change_action**.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **plant_spatial_configuration_-change_assignment** entity:

- **change_item_requires_creation_date** (see 5.2.4.5);
- **change_item_requires_id** (see 5.2.4.6).

5.2.3.1.86 plant_spatial_configuration_organization_assignment

A **plant_spatial_configuration_organization_assignment** assigns an **organization** to a set of one or more **catalogue**s, **change_action**s, **design_project**s, **document**s, **plant**s, **product_definition_-formation**s, **product_definition_relationship**s, and **site**s.

EXPRESS specification:

```
*)
ENTITY plant_spatial_configuration_organization_assignment
  SUBTYPE OF (organization_assignment);
  items : SET [1:?] OF plant_spatial_configuration_organization_item;
WHERE
  WR1: plant_spatial_configuration_organization_correlation (SELF);
END_ENTITY;
   (*
```

Attribute definitions:

items: the set of **catalogue**s, **change_action**s, **design_project**s, **document**s, **plant**s, **product_-definition_formation**s, **product_definition_relationship**s, and **site**s that an **organization** is assigned to.

Formal propositions:

WR1: The **plant_spatial_configuration_organization_correlation** function that correlates roles of organizations to elements of product data shall be satisfied.

5.2.3.1.87 plant_spatial_configuration_person_and_organization_-assignment

A **plant_spatial_configuration_person_and_organization_assignment** assigns a **person_and_-organization** to a set of one or more **change_item**s, **plant**s, and **site**s.

EXPRESS specification:

```
*)
ENTITY plant_spatial_configuration_person_and_organization_assignment
  SUBTYPE OF (person_and_organization_assignment);
  items : SET [1:?] OF
          plant_spatial_configuration_person_and_organization_item;
WHERE
  WR1: plant_spatial_configuration_person_and_organization_correlation
             (SELF);
END_ENTITY;
(*
```

Attribute definitions:

items: the set of **change_item**s, **plant**s, and **site**s that a **person_and_organization** is assigned to.

Formal propositions:

WR1: The **plant_spatial_configuration_person_and_organization_correlation** function that correlates roles of persons and organizations to elements of product data shall be satisfied.

5.2.3.1.88 plant_spatial_configuration_person_assignment

A **plant_spatial_configuration_person_assignment** assigns a **person** to a set of one or more **document**s, **plant**s, **product_definition_relationship**s, and **site**s.

EXPRESS specification:

```
*)
ENTITY plant_spatial_configuration_person_assignment
  SUBTYPE OF (person_assignment);
  items : SET [1:?] OF plant_spatial_configuration_person_item;
WHERE
  WR1: plant_spatial_configuration_person_correlation (SELF);
END_ENTITY;
(*
```

Attribute definitions:

items: the set of **document**s, **plant**s, **product_definition_relationship**s, and **site**s that a **person** is

assigned to.

Formal propositions:

WR1: The **plant_spatial_configuration_person_correlation** function that correlates roles of persons to elements of product data shall be satisfied.

5.2.3.1.89 process_capability

A **process_capability** is a type of **property_definition** that identifies the physical or chemical process that is, or is intended to be, carried out by a **plant**.

EXPRESS specification:

```
*)
ENTITY process_capability
  SUBTYPE OF (property_definition);
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.PLANT' IN
       TYPEOF(SELF.definition\product_definition.formation.of_product);
  WR2: SIZEOF (QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION_REPRESENTATION.' +
       'DEFINITION') |
       (pdr.used_representation.name = 'production capacity') AND
       (NOT (SIZEOF (QUERY (it <* pdr.used_representation.items |
       ('PLANT_SPATIAL_CONFIGURATION.DESCRIPTIVE_REPRESENTATION_ITEM'
       IN TYPEOF (it)) AND
       (it.name = 'production type'))) = 1)))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **process_capability** is a property of a **plant**.

WR2: The **representation** instances associated with a **process_capability** shall have a name of ‘production capacity’ and shall contain exactly one **descriptive_representation_item** with a name of ‘production type’.

5.2.3.1.90 purchase_assignment

A **purchase_assignment** assigns a set of one or more **product**s to an **action** to identify that the **product** is purchased.

EXPRESS specification:

```
*)
ENTITY purchase_assignment
  SUBTYPE OF (action_assignment);
  items : SET [1:?] OF purchase_item;
END_ENTITY;
(*
```

Attribute definitions:

items: the set of **product**s that are purchased.

5.2.3.1.91 reducer_fitting_class

A **reducer_fitting_class** is a type of **group** that classifies the items that are assigned to it as reducer fittings.

EXPRESS specification:

```
*)
ENTITY reducer_fitting_class
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
       'ASSIGNED_CLASS') |
       'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ca)) |
       NOT (SIZEOF (QUERY (it <* aca.items |
       NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)))) = 0))) = 0;
  WR2: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
       'ASSIGNED_CLASS') |
       'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ca)) |
       NOT (SIZEOF (QUERY (pcd <* QUERY (it <* aca.items |
       'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)) |
       NOT (SIZEOF (QUERY (aca1 <* USEDIN (pcd.formation.of_product,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
       class_in_tree (aca1.assigned_class, 'reducer')))
       = 1))) = 0))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **reducer_fitting_class** shall classify items of type **piping_component_definition**.

WR2: A **reducer_fitting_class** shall classify items of type **piping_component_definition** that are a definition of a **product** that is categorized as a ‘reducer’.

5.2.3.1.92 reference_geometry

A **reference_geometry** is a type of **derived_shape_aspect** that is a geometric element that is not part of the definition of the shape of **plant_item**, but is provided as supplementary geometric information. A **reference_geometry** has a relationship to the shape definition geometry and may be derivable from shape geometry.

EXAMPLE Centrelines of symmetric elements and origin points are considered **reference_geometry**.

EXPRESS specification:

```
*)
ENTITY reference_geometry
  SUBTYPE OF (derived_shape_aspect);
WHERE
  WR1: SIZEOF (QUERY (pd <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION.DEFINITION') |
       NOT (SIZEOF (USEDIN (pd, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) >= 1))) = 0;
END_ENTITY;
```

```
(*
```

Formal propositions:

WR1: Each **reference_geometry** shall have at least one **representation**.

5.2.3.1.93 reinforcing_component_definition

A **reinforcing_component_definition** is a type of **product_definition** that defines a reinforcing component.

EXPRESS specification

```
*)
ENTITY reinforcing_component_definition
  SUBTYPE OF (product_definition);
END_ENTITY;
(*
```

5.2.3.1.94 required_material_property

A **required_material_property** is a type of **material_property** that specifies the material or the requirements for the material that a plant item should be made from.

EXPRESS specification:

```
*)
ENTITY required_material_property
  SUBTYPE OF (material_property);
WHERE
  WR1: (SIZEOF (TYPEOF (SELF\property_definition.definition) *
       ['PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR',
       'PLANT_SPATIAL_CONFIGURATION.' +
       'EXTERNALLY_DEFINED_PLANT_ITEM_DEFINITION']) = 1) OR
       (('PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION' IN
       TYPEOF (SELF.definition)) AND
       (SIZEOF (QUERY (pc <* SELF\property_definition.
       definition\product_definition.formation.of_product.
       frame_of_reference |
       pc.discipline_type = 'process plant')) = 1));
  WR2: SIZEOF (QUERY (ra <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_RELATIONSHIP.RELATED_PROPERTY_DEFINITION') |
       pdr.name = 'requirement allocation') |
       'PLANT_SPATIAL_CONFIGURATION.MATERIAL_PROPERTY' IN
       TYPEOF (ra.relating_property_definition))) >= 1;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **required_material_property** shall be a property of a **plant_item_connector**, **externally_-defined_plant_item**, or a **product_definition** that defines a plant item.

WR2: A **required_material_property** shall be related to at least one **material_property** as the ‘requirement allocation’.

5.2.3.1.95 reserved_space

A **reserved_space** is a type of **shape_aspect** that identifies a space that is reserved for a plant item.

```
*)
ENTITY reserved_space
  SUBTYPE OF (shape_aspect);
WHERE
  WR1: SELF\shape_aspect.of_shape\property_definition.
       definition\product_definition.
       frame_of_reference\application_context_element.name =
       'physical occurrence';
END_ENTITY;
(*
```

Formal propositions:

WR1: A **reserved_space** shall be an aspect of the definition of the shape of a **product_definition** with a context with the name 'physical occurrence'.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **reserved_space** entity:

- **application_context_requires_ap_definition** (see 5.2.4.1);
- **dependent_instantiable_application_context** (see 5.2.4.9);
- **dependent_instantiable_product_definition_context** (see 5.2.4.11);
- **product_definition_context_name_constraint** (see 5.2.4.13);
- **product_definition_usage_constraint** (see 5.2.4.14).

5.2.3.1.96 site

A **site** is a type of **characterized_object** and **property_definition** that identifies the geographic and topographic characteristics of the location of a plant.

EXPRESS specification:

```
*)
ENTITY site
  SUBTYPE OF (characterized_object, property_definition);
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.PLANT' IN
       TYPEOF (SELF\property_definition.definition\product_definition.
       formation.of_product);
END_ENTITY;
(*
```

Formal propositions:

WR1: Each **site** shall be a property of a **plant**.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **site** entity:

- **subtype_exclusive_characterized_object** (see 5.2.4.15)

5.2.3.1.97 site_building

A **site_building** is a type of **property_definition** that identifies a partially or totally enclosed structure located on a site.

EXPRESS specification:

```
*)
ENTITY site_building
  SUBTYPE OF (property_definition);
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.SITE' IN
       TYPEOF (SELF.definition);
  WR2: SIZEOF (QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       (pdr.used_representation.name = 'building number') AND
       (SIZEOF (QUERY (it <* pdr.used_representation.items |
       ('PLANT_SPATIAL_CONFIGURATION.DESCRIPTIVE_REPRESENTATION_ITEM' IN
       TYPEOF (it)))) = 1))) = 1;
  WR3: SIZEOF (QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       SIZEOF (QUERY (it <* pdr.used_representation.items |
       (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_2D',
       'PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_3D'] *
       TYPEOF (it)) = 1) AND
       (it.name = 'building orientation') AND
       (it.location.name = 'building location'))) = 1)) <= 1;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **site_building** shall be a property of a site.

WR2: The **site_building** shall have exactly one **representation** with a name of ‘building number’ that contains exactly one **representation_item** that is a **descriptive_representation_item**.

WR3: The **site_building** shall have at most one **representation** that contains exactly one **axis2_-placement_2d** or **axis2_placement_3d** with a **name** of ‘building orientation’ and a **location** that has a **name** of ‘building location’.

5.2.3.1.98 site_feature

A **site_feature** is a type of **property_definition** that identifies the composition, proportions, form or outward appearance of part of a site.

EXPRESS specification:

```
*)
ENTITY site_feature
  SUBTYPE OF (property_definition);
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.SITE' IN
       TYPEOF(SELF.definition);
  WR2: SIZEOF (USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) = 3;
  WR3: SIZEOF (QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       SIZEOF (QUERY (it <* pdr.used_representation.items |
```

```
      ('PLANT_SPATIAL_CONFIGURATION.DESCRIPTIVE_REPRESENTATION_ITEM' IN
      TYPEOF (it)) AND
      (it.name = 'site feature type'))) = 1)) = 1;
  WR4: SIZEOF (QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      SIZEOF (QUERY (it <* pdr.used_representation.items |
      (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_2D',
      'PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_3D'] *
      TYPEOF (it)) = 1) AND
      (it.name = 'feature orientation') AND
      (it.location.name = 'feature location'))) = 1)) = 1;
  WR5: SIZEOF (QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      SIZEOF (QUERY (it <* pdr.used_representation.items |
      ('PLANT_SPATIAL_CONFIGURATION.DESCRIPTIVE_REPRESENTATION_ITEM' IN
      TYPEOF (pdr.used_representation)) AND
      (it.name = 'origin type') AND
      (it.description IN ['man made', 'natural']))) = 1)) = 1;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **site_feature** is a property of a **site**.

WR2: A **site_feature** is referenced by exactly three **property_definition_representation** instances.

WR3: A **site_feature** shall have exactly one **representation** contains exactly one item of type **descriptive_representation_item** with the name of ‘site feature type’.

WR4: The **site_feature** shall have at exactly one **representation** that contains exactly one **axis2_-placement_2d** or **axis2_placement_3d** with a **name** of ‘feature orientation’ and a **location** that has a **name** of ‘feature location’.

WR5: The **site_feature** shall have exactly one **representation** that contains exactly one **representation_item** that is a **descriptive_representation_item** with the name of ‘origin type’ and a **description** of either ‘man made’ or ‘natural’.

5.2.3.1.99 site_representation

A **site_representation** is a type of **shape_representation** that represents the shape properties of a **site**.

EXPRESS specification:

```
*)
ENTITY site_representation
  SUBTYPE OF (shape_representation);
WHERE
  WR1: SIZEOF (QUERY (pdr <* USEDIN (SELF,'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.USED_REPRESENTATION') |
      NOT('PLANT_SPATIAL_CONFIGURATION.SITE' IN
      TYPEOF (pdr.definition.definition)))) = 0;
  WR2: SIZEOF (QUERY (item <* SELF.items |
      NOT (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.CONNECTED_FACE_SET',
      'PLANT_SPATIAL_CONFIGURATION.GEOMETRIC_CURVE_SET'] *
      TYPEOF (item)) = 1))) = 1;
  WR3: SIZEOF (QUERY (cfs <* QUERY (item <* SELF.items |
      'PLANT_SPATIAL_CONFIGURATION.CONNECTED_FACE_SET' IN TYPEOF (item)) |
      NOT (SIZEOF (QUERY (fcs <* cfs\connected_face_set.cfs_faces |
      NOT (SIZEOF (QUERY (bnds <* fcs.bounds |
      NOT ('PLANT_SPATIAL_CONFIGURATION.POLY_LOOP'
```

```
      IN TYPEOF (bnds.bound))))
      = 0))) = 0))) = 0;
  WR4: SIZEOF (QUERY (cfs <* QUERY (item <* SELF.items |
      'PLANT_SPATIAL_CONFIGURATION.CONNECTED_FACE_SET' IN TYPEOF (item)) |
      NOT (SIZEOF (QUERY (fcs <* cfs\connected_face_set.cfs_faces |
      NOT (SIZEOF (QUERY (bnds <* fcs.bounds |
      NOT (SIZEOF (bnds.bound\poly_loop.polygon) = 3)))
      = 0))) = 0))) = 0;
  WR5: SIZEOF (QUERY (gcs <* QUERY (item <* SELF.items |
      'PLANT_SPATIAL_CONFIGURATION.GEOMETRIC_CURVE_SET'
      IN TYPEOF (item)) |
      NOT (SIZEOF (QUERY (el <* gcs\geometric_set.elements |
      NOT (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.CARTESIAN_POINT',
      'PLANT_SPATIAL_CONFIGURATION.POLYLINE'] * TYPEOF (el))
      = 1))) = 0))) = 0;
  WR6: SIZEOF (QUERY (gcs <* QUERY (item <* SELF.items |
      'PLANT_SPATIAL_CONFIGURATION.GEOMETRIC_CURVE_SET'
      IN TYPEOF (item)) |
      NOT (SIZEOF (QUERY (el <* gcs\geometric_set.elements |
      'PLANT_SPATIAL_CONFIGURATION.CARTESIAN_POINT' IN TYPEOF (el)))
      >= 1))) = 0;
  WR7: SIZEOF (QUERY (gcs <* QUERY (item <* SELF.items |
      'PLANT_SPATIAL_CONFIGURATION.GEOMETRIC_CURVE_SET'
      IN TYPEOF (item)) |
      NOT (SIZEOF (QUERY (pline <* QUERY (el <*
      gcs\geometric_set.elements |
      'PLANT_SPATIAL_CONFIGURATION.POLYLINE' IN TYPEOF (el)) |
      NOT (SIZEOF (QUERY (pline_pt <* pline\polyline.points |
      NOT (pline_pt IN gcs\geometric_set.elements))) = 0))) = 0))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **site_representation** shall be used to represent a **site**.

WR2: A **site_representation** shall have in its set of items exactly one **connected_face_set** or **geometric_curve_set**.

WR3: If the **representation_item** is a **connected_face_set**, it shall contain faces that are bounded by **poly_loop**s.

WR4: If the **representation_item** is a **connected_face_set**, all of its **face** instances shall be bounded by **poly_loop**s with topology defined by three **cartesian_point**s.

WR5: If the **representation_item** is a **geometric_curve_set**, its **elements** set shall consist of **cartesian_point** or **polyline**.

WR6: If the **representation_item** is a **geometric_curve_set**, its **elements** shall consist of at least one **cartesian_point**.

WR7: If the **representation_item** is a **geometric_curve_set**, its **elements** that are of type **polyline** shall reference only points that are in the **elements** set.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **site_representation** entity:

- **subtype_mandatory_shape_representation** (see 5.2.4.18)

5.2.3.1.100 sited_plant

A **sited_plant** is a type of **property_definition** that specifies a plant that is located on a site. The location need not be specified.

EXPRESS specification:

```
*)
ENTITY sited_plant
  SUBTYPE OF (property_definition);
UNIQUE
  UR1: SELF\property_definition.definition;
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION' IN TYPEOF
       (SELF.definition);
  WR2: SELF.definition.frame_of_reference.name = 'physical occurrence';
END_ENTITY;
(*
```

Formal propositions:

UR1: Each **sited_plant** shall be related to zero or one **characterized_definition.**

WR1: A **sited_plant** shall be the property of a **product_definition**.

WR2: A **sited_plant** shall be the property of a **product_definition** that is a physical occurrence.

5.2.3.1.101 spacer_fitting_class

A **spacer_fitting_class** is a type of **group** that classifies the items that are assigned to it as spacer fittings.

EXPRESS specification:

```
*)
ENTITY spacer_fitting_class
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
       'ASSIGNED_CLASS') |
       'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ca)) |
       NOT (SIZEOF (QUERY (it <* aca.items |
       NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)))) = 0))) = 0;
  WR2: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
       'ASSIGNED_CLASS') |
       'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ca)) |
       NOT (SIZEOF (QUERY (pcd <* QUERY (it <* aca.items |
       'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)) |
       NOT (SIZEOF (QUERY (aca1 <* USEDIN (pcd.formation.of_product,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
       class_in_tree (aca1.assigned_class, 'spacer')))
       = 1))) = 0))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **spacer_fitting_class** shall classify items of type **piping_component_definition**.

WR2: A **spacer_fitting_class** shall classify items of type **piping_component_definition** that are a definition of a **product** that is categorized as a 'spacer'.

5.2.3.1.102 specialty_item_class

A **specialty_item_class** is a type of **group** that classifies the items are assigned to it as specialty items. The name of the **specialty_item_class** may further classify the assigned items.

EXPRESS specification:

```
*)
ENTITY specialty_item_class
  SUBTYPE OF (group);
END_ENTITY;
(*
```

5.2.3.1.103 stream_design_case

A **stream_design_case** is a type of **property_definition** and **characterized_object** that identifies the characteristics of a gas, liquid, vapour, or particulate stream.

EXPRESS specification:

```
*)
ENTITY stream_design_case
  SUBTYPE OF (property_definition, characterized_object);
WHERE
  WR1: SIZEOF (QUERY (pd <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION.DEFINITION') |
       'PLANT_SPATIAL_CONFIGURATION.STREAM_PHASE' IN
       TYPEOF (pd))) >= 1;
  WR2: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = 'stream flow characteristics')) = 1;
  WR3: SIZEOF (QUERY (sfc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = 'stream flow characteristics') |
       NOT (SIZEOF (sfc.used_representation.items) >= 2))) = 0;
  WR4: SIZEOF (QUERY (sfc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = 'stream flow characteristics') |
       NOT ({1 <= SIZEOF (QUERY (it <* sfc.used_representation.items |
       ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
       TYPEOF (it)) AND
       (it.name IN ['flow rate', 'minimum flow rate',
       'maximum flow rate'])) <= 2}))) = 0;
  WR5: SIZEOF (QUERY (sfc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = 'stream flow characteristics') |
       NOT (SIZEOF (QUERY (it <* sfc.used_representation.items |
       ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
       TYPEOF (it)) AND
       (it.name = 'flow rate'))) <= 1))) = 0;
  WR6: SIZEOF (QUERY (sfc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
```

```
      pdr.used_representation.name = 'stream flow characteristics') |
      NOT (SIZEOF (QUERY (it <* sfc.used_representation.items |
      ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
      TYPEOF (it)) AND
      (it.name = 'minimum flow rate'))) <= 1))) = 0;
 WR7: SIZEOF (QUERY (sfc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'stream flow characteristics') |
      NOT (SIZEOF (QUERY (it <* sfc.used_representation.items |
      ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
      TYPEOF (it)) AND
      (it.name = 'maximum flow rate'))) <= 1))) = 0;
 WR8: SIZEOF (QUERY (sfc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'stream flow characteristics') |
      NOT ({1 <= SIZEOF (QUERY (it <* sfc.used_representation.items |
      ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
      TYPEOF (it)) AND
      (it.name IN ['pressure', 'minimum pressure',
      'maximum pressure'])) <= 2}))) = 0;
 WR9: SIZEOF (QUERY (sfc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'stream flow characteristics') |
      NOT (SIZEOF (QUERY (it <* sfc.used_representation.items |
      ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
      TYPEOF (it)) AND
      (it.name = 'pressure'))) <= 1))) = 0;
WR10: SIZEOF (QUERY (sfc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'stream flow characteristics') |
      NOT (SIZEOF (QUERY (it <* sfc.used_representation.items |
      ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
      TYPEOF (it)) AND
      (it.name = 'minimum pressure'))) <= 1))) = 0;
WR11: SIZEOF (QUERY (sfc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'stream flow characteristics') |
      NOT (SIZEOF (QUERY (it <* sfc.used_representation.items |
      ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
      TYPEOF (it)) AND
      (it.name = 'maximum pressure'))) <= 1))) = 0;
WR12: SIZEOF (QUERY (sfc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'stream flow characteristics') |
      NOT (SIZEOF (QUERY (it <* sfc.used_representation.items |
      ('PLANT_SPATIAL_CONFIGURATION.DESCRIPTIVE_REPRESENTATION_ITEM' IN
      TYPEOF (it)) AND
      (it.name = 'stream data reference'))) <= 1))) = 0;
WR13: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
      pdr.related_property_definition.name =
      'service characteristics')) >= 1)) OR
      (SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
      pdr.related_property_definition.name =
      'service characteristics') |
      NOT (SIZEOF (QUERY (pdr <* USEDIN (sc.related_property_definition,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name =
      'service operating characteristics')) = 1))) = 0);
WR14: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
```

```
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
      pdr.related_property_definition.name =
      'service characteristics')) >= 1)) OR
      (SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
      pdr.related_property_definition.name =
      'service characteristics') |
      NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
      USEDIN (sc.related_property_definition,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name =
      'service operating characteristics') |
      NOT (SIZEOF (soc.used_representation.items) >= 3))) = 0))) = 0);
WR15: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
      pdr.related_property_definition.name =
      'service characteristics')) >= 1)) OR
      (SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
      pdr.related_property_definition.name = 'service characteristics') |
      NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
      USEDIN (sc.related_property_definition,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name =
      'service operating characteristics') |
      {1 <= SIZEOF (QUERY (it <* soc.used_representation.items |
      (SIZEOF (TYPEOF (it) *
      ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.' +
      'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
      (it.name IN ['temperature', 'minimum temperature',
      'maximum temperature'])))  <= 2})) = 1))) = 0);
WR16: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
      pdr.related_property_definition.name =
      'service characteristics')) >= 1)) OR
      (SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
      pdr.related_property_definition.name = 'service characteristics') |
      NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
      USEDIN (sc.related_property_definition,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name =
      'service operating characteristics') |
      SIZEOF (QUERY (it <* soc.used_representation.items |
      (SIZEOF (TYPEOF (it) *
      ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.' +
      'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
      (it.name = 'temperature'))) <= 1)) = 1))) = 0);
WR17: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
      pdr.related_property_definition.name =
      'service characteristics')) >= 1)) OR
      (SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
      pdr.related_property_definition.name = 'service characteristics') |
      NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
      USEDIN (sc.related_property_definition,
```

```
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name =
      'service operating characteristics') |
      SIZEOF (QUERY (it <* soc.used_representation.items |
      (SIZEOF (TYPEOF (it) *
      ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.' +
      'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
      (it.name = 'minimum temperature'))) <= 1)) = 1))) = 0);
WR18: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
      pdr.related_property_definition.name =
      'service characteristics')) >= 1)) OR
      (SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
      pdr.related_property_definition.name = 'service characteristics') |
      NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
      USEDIN (sc.related_property_definition,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name =
      'service operating characteristics') |
      SIZEOF (QUERY (it <* soc.used_representation.items |
      (SIZEOF (TYPEOF (it) *
      ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.' +
      'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
      (it.name = 'maximum temperature'))) <= 1)) = 1))) = 0);
WR19: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
      pdr.related_property_definition.name =
      'service characteristics')) >= 1)) OR
      (SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
      pdr.related_property_definition.name = 'service characteristics') |
      NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
      USEDIN (sc.related_property_definition,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name =
      'service operating characteristics') |
      {1 <= SIZEOF (QUERY (it <* soc.used_representation.items |
      ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
      TYPEOF (it)) AND
      (it.name IN ['pressure', 'minimum pressure',
      'maximum pressure']))) <= 2})) = 1))) = 0);
WR20: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
      pdr.related_property_definition.name =
      'service characteristics')) >= 1)) OR
      (SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
      pdr.related_property_definition.name = 'service characteristics') |
      NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
      USEDIN (sc.related_property_definition,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name =
      'service operating characteristics') |
      SIZEOF (QUERY (it <* soc.used_representation.items |
      ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
      TYPEOF (it)) AND
      (it.name = 'pressure'))) <= 1)) = 1))) = 0);
```

```
 WR21: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
       pdr.related_property_definition.name =
       'service characteristics')) >= 1)) OR
       (SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
       pdr.related_property_definition.name = 'service characteristics') |
       NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
       USEDIN (sc.related_property_definition,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name =
       'service operating characteristics') |
       SIZEOF (QUERY (it <* soc.used_representation.items |
       ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
       TYPEOF (it)) AND
       (it.name = 'minimum pressure'))) <= 1)) = 1))) = 0);
 WR22: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
       pdr.related_property_definition.name =
       'service characteristics')) >= 1)) OR
       (SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
       pdr.related_property_definition.name = 'service characteristics') |
       NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
       USEDIN (sc.related_property_definition,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name =
       'service operating characteristics') |
       SIZEOF (QUERY (it <* soc.used_representation.items |
       ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
       TYPEOF (it)) AND
       (it.name = 'maximum pressure'))) <= 1)) = 1))) = 0);
 WR23: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
       pdr.related_property_definition.name =
       'service characteristics')) >= 1)) OR
       (SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
       pdr.related_property_definition.name = 'service characteristics') |
       NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
       USEDIN (sc.related_property_definition,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name =
       'service operating characteristics') |
       {1 <= SIZEOF (QUERY (it <* soc.used_representation.items |
       (SIZEOF (TYPEOF (it) *
       ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
       'PLANT_SPATIAL_CONFIGURATION.TIME_MEASURE_WITH_UNIT']) = 2) AND
       (it.name IN ['duration', 'minimum duration',
       'maximum duration'])))  <= 2})) = 1))) = 0);
 WR24: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
       pdr.related_property_definition.name =
       'service characteristics')) >= 1)) OR
       (SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
       pdr.related_property_definition.name = 'service characteristics') |
       NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
       USEDIN (sc.related_property_definition,
```

```
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        pdr.used_representation.name =
        'service operating characteristics') |
        SIZEOF (QUERY (it <* soc.used_representation.items |
        (SIZEOF (TYPEOF (it) *
        ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
        'PLANT_SPATIAL_CONFIGURATION.TIME_MEASURE_WITH_UNIT']) = 2) AND
        (it.name = 'duration'))) <= 1)) = 1))) = 0);
 WR25: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
        pdr.related_property_definition.name =
        'service characteristics')) >= 1)) OR
        (SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
        pdr.related_property_definition.name = 'service characteristics') |
        NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
        USEDIN (sc.related_property_definition,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        pdr.used_representation.name =
        'service operating characteristics') |
        SIZEOF (QUERY (it <* soc.used_representation.items |
        (SIZEOF (TYPEOF (it) *
        ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
        'PLANT_SPATIAL_CONFIGURATION.TIME_MEASURE_WITH_UNIT']) = 2) AND
        (it.name = 'minimum duration'))) <= 1)) = 1))) = 0);
 WR26: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
        pdr.related_property_definition.name =
        'service characteristics')) >= 1)) OR
        (SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
        pdr.related_property_definition.name = 'service characteristics') |
        NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
        USEDIN (sc.related_property_definition,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        pdr.used_representation.name =
        'service operating characteristics') |
        SIZEOF (QUERY (it <* soc.used_representation.items |
        (SIZEOF (TYPEOF (it) *
        ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
        'PLANT_SPATIAL_CONFIGURATION.TIME_MEASURE_WITH_UNIT']) = 2) AND
        (it.name = 'maximum duration'))) <= 1)) = 1))) = 0);
 WR27: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
        pdr.related_property_definition.name =
        'service characteristics')) >= 1)) OR
        (SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
        pdr.related_property_definition.name = 'service characteristics') |
        NOT ('PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR' IN
        TYPEOF (sc.related_property_definition.definition)))) = 0);
END_ENTITY;
(*
```

Formal propositions:

WR1: A **stream_design_case** shall have at least one **stream_phase**.

WR2: A **stream_design_case** shall have exactly one representation with the **name** of ‘stream flow

characteristics'.

WR3: The representation of the **stream_design_case** with the **name** of 'stream flow characteristics' shall have at least two **representation_item**s.

WR4: The representation of the **stream_design_case** with the **name** of 'stream flow characteristics' shall have between one and two **representation_item**s that are of type **measure_representation_item** with a name of 'flow rate', 'maximum flow rate', or 'minimum flow rate'.

WR5: The representation of the **stream_design_case** with the **name** of 'stream flow characteristics' shall have at most one **representation_item** that is of type **measure_representation_item** with a name of 'flow rate'.

WR6: The representation of the **stream_design_case** with the **name** of 'stream flow characteristics' shall have at most one **representation_item** that is of type **measure_representation_item** with a name of 'minimum flow rate'.

WR7: The representation of the **stream_design_case** with the **name** of 'stream flow characteristics' shall have at most one **representation_item** that is of type **measure_representation_item** with a name of 'maximum flow rate'.

WR8: The representation of the **stream_design_case** with the **name** of 'stream flow characteristics' shall have between one and two **representation_item**s that are of type **measure_representation_item** with a name of 'pressure', 'maximum pressure', or 'minimum pressure'.

WR9: The representation of the **stream_design_case** with the **name** of 'stream flow characteristics' shall have at most one **representation_item** that is of type **measure_representation_item** with a name of 'pressure'.

WR10: The representation of the **stream_design_case** with the **name** of 'stream flow characteristics' shall have at most one **representation_item** that is of type **measure_representation_item** with a name of 'minimum pressure'.

WR11: The representation of the **stream_design_case** with the **name** of 'stream flow characteristics' shall have at most one **representation_item** that is of type **measure_representation_item** with a name of 'maximum pressure'.

WR12: The representation of the **stream_design_case** with the **name** of 'stream flow characteristics' shall have at most one **representation_item** that is of type **descriptive_representation_item** with a name of 'stream reference data'.

WR13: If the **stream_design_case** relates to a **property_definition** with a **name** of 'service characteristics', the **property_definition** that is related with a **name** of 'service characteristics' shall have exactly one **representation** with the **name** of 'stream operating characteristics'.

WR14: If the **stream_design_case** relates to a **property_definition** with a **name** of 'service characteristics', the **representation** with the **name** of 'stream operating characteristics' of that **property_-definition** shall have at least three **representation_item**s.

WR15: If the **stream_design_case** relates to a **property_definition** with a **name** of 'service characteristics', the **representation** with the **name** of 'stream operating characteristics' of that **property_-definition** shall have one or two **representation_item**s of type **measure_representation_item** and **thermodynamic_temperature_measure_with_unit** with a **name** of 'temperature', 'minimum

temperature', or 'maximum temperature'.

WR16: If the **stream_design_case** relates to a **property_definition** with a **name** of 'services characteristics', the **representation** with the **name** of 'stream operating characteristics' of that **property_definition** shall have at most one **representation_item** of type **measure_representation_item** and **thermodynamic_temperature_measure_with_unit** with a **name** of 'temperature'.

WR17: If the **stream_design_case** relates to a **property_definition** with a **name** of 'service characteristics', the **representation** with the **name** of 'stream operating characteristics' of that **property_definition** shall have at most one **representation_item** of type **measure_representation_item** and **thermodynamic_temperature_measure_with_unit** with a **name** of 'minimum temperature'.

WR18: If the **stream_design_case** relates to a **property_definition** with a **name** of 'service characteristics', the **representation** with the **name** of 'stream operating characteristics' of that **property_definition** shall have at most one **representation_item** of type **measure_representation_item** and **thermodynamic_temperature_measure_with_unit** with a **name** of 'maximum temperature'.

WR19: If the **stream_design_case** relates to a **property_definition** with a **name** of 'service characteristics', the **representation** with the **name** of 'stream operating characteristics' of that **property_definition** shall have one or two **representation_item**s of type **measure_representation_item** with a **name** of 'pressure', 'minimum pressure', or 'maximum pressure'.

WR20: If the **stream_design_case** relates to a **property_definition** with a **name** of 'service characteristics', the **representation** with the **name** of 'stream operating characteristics' of that **property_definition** shall have at most one **representation_item** of type **measure_representation_item** with a **name** of 'pressure'.

WR21: If the **stream_design_case** relates to a **property_definition** with a **name** of 'service characteristics', the **representation** with the **name** of 'stream operating characteristics' of that **property_definition** shall have at most one **representation_item** of type **measure_representation_item** with a **name** of 'minimum pressure'.

WR22: If the **stream_design_case** relates to a **property_definition** with a **name** of 'service characteristics', the **representation** with the **name** of 'stream operating characteristics' of that **property_definition** shall have at most one **representation_item** of type **measure_representation_item** with a **name** of 'maximum pressure'.

WR23: If the **stream_design_case** relates to a **property_definition** with a **name** of 'service characteristics', the **representation** with the **name** of 'stream operating characteristics' of that **property_definition** shall have one or two **representation_item**s of type **measure_representation_item** and **time_measure_with_unit** with a **name** of 'duration', 'minimum duration', or 'maximum duration'.

WR24: If the **stream_design_case** relates to a **property_definition** with a **name** of 'service characteristics', the **representation** with the **name** of 'stream operating characteristics' of that **property_definition** shall have at most one **representation_item** of type **measure_representation_item** and **time_measure_with_unit** with a **name** of 'duration'.

WR25: If the **stream_design_case** relates to a **property_definition** with a **name** of 'service characteristics', the **representation** with the **name** of 'stream operating characteristics' of that **property_definition** shall have at most one **representation_item** of type **measure_representation_item** and **time_measure_with_unit** with a **name** of 'minimum duration'.

WR26: If the **stream_design_case** relates to a **property_definition** with a **name** of 'service characteristics', the **representation** with the **name** of 'stream operating characteristics' of that

property_definition shall have at most one **representation_item** of type **measure_representation_item** and **time_measure_with_unit** with a **name** of 'maximum duration'.

WR27: If the **stream_design_case** relates to a **property_definition** with a **name** of 'service characteristics', that **property_definition** shall be a property of a **plant_item_connector**.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **stream_design_case** entity:

- **subtype_exclusive_characterized_object** (see 5.2.4.15)

5.2.3.1.104 stream_phase

A **stream_phase** is a type of **property_definition** that identifies the characteristics of a gas, liquid, vapour, or particulate phase.

EXPRESS specification:

```
*)
ENTITY stream_phase
  SUBTYPE OF (property_definition);
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.STREAM_DESIGN_CASE' IN
       TYPEOF (SELF.DEFINITION);
  WR2: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = 'stream phase characteristics')) = 1;
  WR3: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = 'stream phase characteristics') |
       NOT (SIZEOF (spc.used_representation.items) >= 5))) = 0;
  WR4: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = 'stream phase characteristics') |
       NOT (SIZEOF (QUERY (it <* spc.used_representation.items |
       (SIZEOF (TYPEOF (it) *
       ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
       'PLANT_SPATIAL_CONFIGURATION.RATIO_MEASURE_WITH_UNIT']) = 2) AND
       (it.name = 'constituent mole fraction'))) = 1))) = 0;
  WR5: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = 'stream phase characteristics') |
       NOT (SIZEOF (QUERY (it <* spc.used_representation.items |
       ('PLANT_SPATIAL_CONFIGURATION.DESCRIPTIVE_REPRESENTATION_ITEM' IN
       TYPEOF (it)) AND
       (it.name = 'constituents'))) = 1))) = 0;
  WR6: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = 'stream phase characteristics') |
       NOT (SIZEOF (QUERY (it <* spc.used_representation.items |
       ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
       TYPEOF (it)) AND
       (it.name = 'phase density'))) = 1))) = 0;
  WR7: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = 'stream phase characteristics') |
       NOT (SIZEOF (QUERY (it <* spc.used_representation.items |
       (SIZEOF (TYPEOF (it) *
```

```
      ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.RATIO_MEASURE_WITH_UNIT']) = 2) AND
      (it.name = 'phase fraction'))) = 1))) = 0;
  WR8: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'stream phase characteristics') |
      NOT ({1 <= SIZEOF (QUERY (it <* spc.used_representation.items |
      (SIZEOF (TYPEOF (it) *
      ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.' +
      'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
      (it.name IN ['temperature', 'minimum temperature',
      'maximum temperature'])))  <= 2}))) = 0;
  WR9: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'stream phase characteristics') |
      NOT (SIZEOF (QUERY (it <* spc.used_representation.items |
      (SIZEOF (TYPEOF (it) *
      ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.' +
      'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
      (it.name = 'temperature'))) <= 1))) = 0;
 WR10: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'stream phase characteristics') |
      NOT (SIZEOF (QUERY (it <* spc.used_representation.items |
      (SIZEOF (TYPEOF (it) *
      ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.' +
      'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
      (it.name = 'minimum temperature'))) <= 1))) = 0;
 WR11: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'stream phase characteristics') |
      NOT (SIZEOF (QUERY (it <* spc.used_representation.items |
      (SIZEOF (TYPEOF (it) *
      ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.' +
      'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
      (it.name = 'maximum temperature'))) <= 1))) = 0;
 WR12: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'stream phase characteristics') |
      NOT (SIZEOF (QUERY (it <* spc.used_representation.items |
      ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
      TYPEOF (it)) AND
      (it.name = 'specific gravity'))) <= 1))) = 0;
 WR13: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'stream phase characteristics') |
      NOT (SIZEOF (QUERY (it <* spc.used_representation.items |
      ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
      TYPEOF (it)) AND
      (it.name = 'surface tension'))) <= 1))) = 0;
 WR14: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'stream phase characteristics') |
      NOT (SIZEOF (QUERY (it <* spc.used_representation.items |
      ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
      TYPEOF (it)) AND
      (it.name = 'viscosity'))) <= 1))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **stream_phase** shall define a property of a **stream_design_case**.

WR2: A **stream_phase** shall have exactly one **representation** with the name of 'stream phase characteristics'.

WR3: The representation of the **stream_phase** with the name of 'stream phase characteristics' shall have at least five **representation_item**s.

WR4: The representation of the **stream_phase** with the name of 'stream phase characteristics' shall have exactly one **representation_item** that is of type **measure_representation_item** and **ratio_measure_-with_unit** with a name of 'constituent mole fraction'.

WR5: The representation of the **stream_phase** with the name of 'stream phase characteristics' shall have exactly one **representation_item** that is of type **descriptive_representation_item** with a name of 'constituents'.

WR6: The representation of the **stream_phase** with the name of 'stream phase characteristics' shall have exactly one **representation_item** that is of type **measure_representation_item** with a name of 'phase density'.

WR7: The representation of the **stream_phase** with the name of 'stream phase characteristics' shall have exactly one **representation_item** that is of type **measure_representation_item** and **ratio_measure_-with_unit** with a name of 'phase fraction'.

WR8: The representation of the **stream_phase** with the name of 'stream phase characteristics' shall have one or two **representation_item**s of type **measure_representation_item** and **thermodynamic_-temperature_measure_with_unit** with a **name** of 'temperature', 'minimum temperature', or 'maximum temperature'.

WR9: The representation of the **stream_phase** with the name of 'stream phase characteristics' shall have at most one **representation_item** of type **measure_representation_item** and **thermodynamic_-temperature_measure_with_unit** with a **name** of 'temperature'.

WR10: The representation of the **stream_phase** with the name of 'stream phase characteristics' shall have at most one **representation_item** of type **measure_representation_item** and **thermodynamic_-temperature_measure_with_unit** with a **name** of 'minimum temperature'.

WR11: The representation of the **stream_phase** with the name of 'stream phase characteristics' shall have at most one **representation_item** of type **measure_representation_item** and **thermodynamic_-temperature_measure_with_unit** with a **name** of 'maximum temperature'.

WR12: The representation of the **stream_phase** with the name of 'stream phase characteristics' shall have at most one **representation_item** that is of type **measure_representation_item** with a name of 'specific gravity'.

WR13: The representation of the **stream_phase** with the name of 'stream phase characteristics' shall have at most one **representation_item** that is of type **measure_representation_item** with a name of 'surface tension'.

WR14: The representation of the **stream_phase** with the name of 'stream phase characteristics' shall have at most one **representation_item** that is of type **measure_representation_item** with a name of

'viscosity'.

5.2.3.1.105 structural_load_connector_class

A **structural_load_connector_class** is a type of **group** that classifies the items that are assigned to it as being structural load connectors. The **name** of the **structural_connector_class** further classifies the assigned items.

EXPRESS specification:

```
*)
ENTITY structural_load_connector_class
  SUBTYPE OF (group);
END_ENTITY;
(*
```

5.2.3.1.106 structural_system

A **structural_system** is a type of **product_definition** that identifies a system or assembly of structural components.

EXPRESS specification:

```
*)
ENTITY structural_system
  SUBTYPE OF (product_definition);
WHERE
  WR1: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
       ('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF
       (pdr.relating_product_definition.formation.of_product)) AND
       (pdr.relating_product_definition.frame_of_reference.name =
       'functional occurrence'))) = 1;
END_ENTITY;
(*
```

Formal propositions:

WR1: The **structural_system** shall be related to exactly one **product_definition** that is the definition of a plant and has a context of 'functional occurrence'.

5.2.3.1.107 support_constraint_representation

A **support_constraint_representation** is a type of **representation** that identifies limitations on the movement of a plant item.

EXPRESS specification:

```
*)
ENTITY support_constraint_representation
  SUBTYPE OF (representation);
WHERE
  WR1: SIZEOF (SELF.items) >= 3;
  WR2: SIZEOF (QUERY (it <* SELF.items |
       ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
       IN TYPEOF (it)) AND
       (it.name IN ['negative x', 'positive x', 'negative y',
       'positive y', 'negative z', 'positive z',
       'negative x rotation', 'positive x rotation',
       'negative y rotation', 'positive y rotation',
```

```
      'negative z rotation', 'positive z rotation'] ))) = 1;
  WR3: SIZEOF (QUERY (it <* SELF.items |
       'PLANT_SPATIAL_CONFIGURATION.RATIO_MEASURE_WITH_UNIT'
       IN TYPEOF (it))) = 1;
  WR4: SIZEOF (QUERY (it <* SELF.items |
       'PLANT_SPATIAL_CONFIGURATION.DESCRIPTIVE_REPRESENTATION_ITEM'
       IN TYPEOF (it))) = 1;
END_ENTITY;
(*
```

Formal propositions:

WR1: The **support_constraint_representation** shall contain at least three items.

WR2: The **support_constraint_representation** shall contain **measure_representation_item**s that have a name of ‘negative x’, ‘positive x’, ‘negative y’, ‘positive y’, ‘negative z’, ‘positive z’, ‘negative x rotation’, ‘positive x rotation’, ‘negative y rotation’, ‘positive y rotation’, ‘negative z rotation’, or ‘positive z rotation’.

WR3: The **support_constraint_representation** shall contain exactly one **ratio_measure_with_unit**.

WR4: The **support_constraint_representation** shall contain exactly one **descriptive_representation_-item**.

5.2.3.1.108 swage_fitting_class

A **swage_fitting_class** is a type of **group** that classifies the items that are assigned to it as swage fittings.

EXPRESS specification:

```
*)
ENTITY swage_fitting_class
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
       'ASSIGNED_CLASS') |
       'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ca)) |
       NOT (SIZEOF (QUERY (it <* aca.items |
       NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)))) = 0))) = 0;
  WR2: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
       'ASSIGNED_CLASS') |
       'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ca)) |
       NOT (SIZEOF (QUERY (pcd <* QUERY (it <* aca.items |
       'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)) |
       NOT (SIZEOF (QUERY (aca1 <* USEDIN (pcd.formation.of_product,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
       class_in_tree (aca.assigned_class, 'swage')))
       = 1))) = 0))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **swage_fitting_class** shall classify items of type **piping_component_definition**.

WR2: A **swage_fitting_class** shall classify items of type **piping_component_definition** that are a definition of a **product** that is categorized as a 'swage'.

5.2.3.1.109 system_class

A **system_class** is a type of **group** that classifies items that are assigned to it as systems. The name of the **system_class** may further classify the assigned item.

EXPRESS specification:

```
*)
ENTITY system_class
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
       'ASSIGNED_CLASS') |
       'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ca)) |
       NOT (SIZEOF (QUERY (it <* aca.items |
       NOT (SIZEOF (TYPEOF (it) *
       ['PLANT_SPATIAL_CONFIGURATION.CABLEWAY_SYSTEM',
       'PLANT_SPATIAL_CONFIGURATION.DUCTING_SYSTEM',
       'PLANT_SPATIAL_CONFIGURATION.ELECTRICAL_SYSTEM',
       'PLANT_SPATIAL_CONFIGURATION.INSTRUMENTATION_AND_CONTROL_SYSTEM',
       'PLANT_SPATIAL_CONFIGURATION.PIPING_SYSTEM',
       'PLANT_SPATIAL_CONFIGURATION.STRUCTURAL_SYSTEM']) = 1)
       )) = 0))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **system_class** shall classify items of type **cableway_system**, **ducting_system**, **electrical_-system**, **instrumentation_and_control_system**, **piping_system**, and **structural_system**.

5.2.3.1.110 system_space

A **system_space** is a type of **product_definition_shape** that identifies the shape of the space allocated for an **electrical_system**, **ducting_system**, **instrumentation_and_control_system**, **piping_system**, or **structural_system**.

EXPRESS specification:

```
*)
ENTITY system_space
  SUBTYPE OF (product_definition_shape);
WHERE
  WR1: SIZEOF (TYPEOF (SELF.definition) *
       ['PLANT_SPATIAL_CONFIGURATION.ELECTRICAL_SYSTEM',
       'PLANT_SPATIAL_CONFIGURATION.DUCTING_SYSTEM',
       'PLANT_SPATIAL_CONFIGURATION.' +
       'INSTRUMENTATION_AND_CONTROL_SYSTEM',
       'PLANT_SPATIAL_CONFIGURATION.PIPING_SYSTEM',
       'PLANT_SPATIAL_CONFIGURATION.STRUCTURAL_SYSTEM']) = 1;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **system_space** shall define the shape of the space allocation for an **electrical_system**, **ducting_-**

system, **instrumentation_and_control_system**, **piping_system**, or **structural_system**.

5.2.3.1.111 valve_class

A **valve_class** is a type of **group** that classifies the items are assigned to it as valves. The name of the **valve_class** may further classify the assigned items.

EXPRESS specification:

```
*)
ENTITY valve_class
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
       'ASSIGNED_CLASS') |
       'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ca)) |
       NOT (SIZEOF (QUERY (it <* aca.items |
       NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)))) = 0))) = 0;
  WR2: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
       'ASSIGNED_CLASS') |
       'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ca)) |
       NOT (SIZEOF (QUERY (pcd <* QUERY (it <* aca.items |
       'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)) |
       NOT (SIZEOF (QUERY (aca1 <* USEDIN (pcd.formation.of_product,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
       class_in_tree (aca1.assigned_class, 'valve')))
       = 1))) = 0))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **valve_class** shall classify items of type **piping_component_definition**.

WR2: A **valve_class** shall classify items of type **piping_component_definition** that are a definition of a **product** that is categorized as a ‘valve’.

5.2.3.2 Plant spatial configuration imported entity modifications

5.2.3.2.1 action_request_status

The base definition of the **action_request_status** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **action_request_status** entity:

- **change_life_cycle_stage_usage_requires_stage** (see 5.2.4.8).

5.2.3.2.2 application_context

The base definition of the **application_context** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **application_context** entity:

- **application_context_requires_ap_definition** (see 5.2.4.1);
- **dependent_instantiable_application_context** (see 5.2.4.9).

5.2.3.2.3 application_protocol_definition

The base definition of the **application_protocol_definition** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **application_protocol_-definition** entity:

- **application_context_requires_ap_definition** (see 5.2.4.1).

5.2.3.2.4 approval

The base definition of the **approval** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **approval** entity:

- **approval_requires_approval_date_time** (see 5.2.4.2);
- **approval_requires_approval_person_organization** (see 5.2.4.3).

5.2.3.2.5 approval_date_time

The base definition of the **approval_date_time** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **approval_date_time** entity:

- **approval_requires_approval_date_time** (see 5.2.4.2).

5.2.3.2.6 approval_person_organization

The base definition of the **approval_person_organization** entity is given in ISO 10303-41. The

following modifications apply to this part of ISO 10303.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **approval_person_-organization** entity:

- **approval_requires_approval_person_organization** (see 5.2.4.3).

5.2.3.2.7 description_attribute

The base definition of the **description_attribute** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **description_attribute** entity:

- **version2_p41_uninstantiable_basic_attributes** (see 5.2.4.21).

5.2.3.2.8 externally_defined_item

The base definition of the **externally_defined_item** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **externally_defined_item** entity:

- **subtype_mandatory_externally_defined_item** (see 5.2.4.16).

5.2.3.2.9 id_attribute

The base definition of the **description_attribute** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **id_attribute** entity:

- **version2_p41_uninstantiable_basic_attributes** (see 5.2.4.21).

5.2.3.2.10 name_attribute

The base definition of the **name_attribute** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **description_attribute** entity:

- **version2_p41_uninstantiable_basic_attributes** (see 5.2.4.21).

5.2.3.2.11 pre_defined_item

The base definition of the **pre_defined_item** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **pre_defined_item** entity:

- **subtype_mandatory_defined_item** (see 5.2.4.17).

5.2.3.2.12 product_context

The base definition of the **product_context** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **product_context** entity:

- **dependent_instantiable_product_context** (see 5.2.4.10);
- **product_context_discipline_type_constraint** (see 5.2.4.12).

5.2.3.2.13 product_definition

The base definition of the **product_definition** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **product_definition** entity:

- product_definition_usage_constraint (see 5.2.4.14).

5.2.3.2.14 product_definition_context

The base definition of the **product_definition_context** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **product_definition_context** entity:

- **dependent_instantiable_product_definition_context** (see 5.2.4.11);
- **product_definition_context_name_constraint** (see 5.2.4.13).

5.2.3.2.15 role_association

The base definition of the **role_association** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **role_association** entity:

- version2_p41_object_role_selection (see 5.2.4.20).

5.2.3.2.16 versioned_action_request

The base definition of the **versioned_action_request** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **versioned_action_request** entity:

- **change_life_cycle_stage_usage_requires_approval** (see 5.2.4.7);
- **change_life_cycle_stage_usage_requires_stage** (see 5.2.4.8);

5.2.4 Plant spatial configuration rule definitions

5.2.4.1 application_context_requires_ap_definition

The **application_context_requires_ap_definition** rule specifies that each instance of **application_-context** shall be referenced by exactly one **application_protocol_definition** that specifies this part of ISO 10303.

EXPRESS specification:

```
*)
RULE application_context_requires_ap_definition FOR
  (application_context, application_protocol_definition);
WHERE
  WR1: SIZEOF (QUERY (ac <* application_context |
       NOT (SIZEOF (QUERY (apd <* application_protocol_definition |
       (ac :=: apd.application)
       AND
       (apd.application_interpreted_model_schema_name =
       'plant_spatial_configuration'))) = 1 ))) = 0;
END_RULE;
(*
```

Argument definitions:

application_context: the set of all instances of the **application_context** entity data type.

application_protocol_definition: the set of all instances of the **application_protocol_definition** entity data type.

Formal propositions:

WR1: For each instance of **application_context**, there shall be exactly one instance of **application_-protocol_definition** that references the instance of **application_context** as its **application** with a value of ‘plant_spatial_configuration’ as its **application_interpreted_model_schema_name**.

5.2.4.2 approval_requires_approval_date_time

Every **approval** shall have exactly one **approval_date_time**.

EXPRESS specification:

```
*)
RULE approval_requires_approval_date_time FOR
  (approval_date_time,
   approval);
WHERE
  WR1: SIZEOF (QUERY (app <* approval |
       NOT (SIZEOF (QUERY (adt <* approval_date_time |
       (app :=: adt.dated_approval))) = 1))) = 0;
END_RULE;
(*
```

Formal propositions:

WR1: For each **approval** there shall be exactly one **approval_date_time** that has the **approval** as its **dated_approval**.

5.2.4.3 approval_requires_approval_person_organization

Every **approval** shall have exactly one **approval_person_organization**.

EXPRESS specification:

```
*)
RULE approval_requires_approval_person_organization FOR
  (approval_person_organization,
   approval);
WHERE
  WR1: SIZEOF (QUERY (app <* approval |
       NOT (SIZEOF (QUERY (apo <* approval_person_organization |
       (app :=: apo.authorized_approval))) = 1))) = 0;
END_RULE;
(*
```

Formal propositions:

WR1: For each **approval** there shall be exactly one **approval_person_organization** that has the **approval** as its **authorized_approval**.

5.2.4.4 change_action_requires_date

Every **change_action** shall have a date assigned to it.

EXPRESS specification:

```
*)
RULE change_action_requires_date FOR
  (change_action,
```

```
   applied_date_assignment);
WHERE
  WR1: SIZEOF (QUERY (ca <* change_action |
       NOT (SIZEOF (QUERY (pscda <*
       applied_date_assignment |
       (ca IN pscda.items))) = 1))) = 0;
END_RULE;
(*
```

Formal propositions:

WR1: For each **change_action** there shall be exactly one **applied_date_assignment** that contains the **change_action** in its set of **items**.

5.2.4.5 change_item_requires_creation_date

Every item of a **plant_spatial_configuration_change_assignment** shall have a date assigned to it with the role of ‘creation date’.

EXPRESS specification:

```
*)
RULE change_item_requires_creation_date FOR
  (plant_spatial_configuration_change_assignment,
   applied_date_assignment);
WHERE
  WR1: SIZEOF (QUERY (pscca <*
           plant_spatial_configuration_change_assignment |
       NOT (SIZEOF (QUERY (ch_it <* pscca.items |
       NOT (SIZEOF (QUERY (pscda <*
           applied_date_assignment |
       (NOT (ch_it IN pscda.items) OR
       (pscda.role.name = 'creation date')))) = 1))) = 0))) = 0;
END_RULE;
(*
```

Formal propositions:

WR1: For each item of a **plant_spatial_configuration_change_assignment** there shall be exactly one **applied_date_assignment** with a role of ‘creation date’ that assigns a date to the item.

5.2.4.6 change_item_requires_id

Every item of a **plant_spatial_configuration_change_assignment** shall have an identification assigned to it.

EXPRESS specification:

```
*)
RULE change_item_requires_id FOR
  (plant_spatial_configuration_change_assignment,
   change_item_id_assignment);
WHERE
  WR1: SIZEOF (QUERY (pscca <*
           plant_spatial_configuration_change_assignment |
       NOT (SIZEOF (QUERY (ch_it <* pscca.items |
       NOT (SIZEOF (QUERY (ciia <* change_item_id_assignment |
       (ch_it IN ciia.items))) = 1))) = 0))) = 0;
END_RULE;
(*
```

Formal propositions:

WR1: For each item of a **plant_spatial_configuration_change_assignment** there shall be exactly one **change_item_id_assignment** that assigns an identification to the item.

5.2.4.7 change_life_cycle_stage_usage_requires_approval

Every **versioned_action_request** shall have an approval assigned to it.

EXPRESS specification:

```
*)
RULE change_life_cycle_stage_usage_requires_approval FOR
  (versioned_action_request,
   applied_approval_assignment);
WHERE
  WR1: SIZEOF (QUERY (vareq <* versioned_action_request |
       NOT (SIZEOF (QUERY (pscaa <*
       applied_approval_assignment |
       vareq IN pscaa.items)) = 1))) = 0;
END_RULE;
(*
```

Formal propositions:

WR1: For each **versioned_action_request** there shall be exactly one **applied_approval_assignment** that contains the **versioned_action_request** in its set of items.

5.2.4.8 change_life_cycle_stage_usage_requires_stage

Every **versioned_action_request** shall have a status assigned to it.

EXPRESS specification:

```
*)
RULE change_life_cycle_stage_usage_requires_stage FOR
  (versioned_action_request,
   action_request_status);
WHERE
  WR1: SIZEOF (QUERY (vareq <* versioned_action_request |
       NOT (SIZEOF (QUERY (ars <* action_request_status |
       vareq :=: ars.assigned_request)) = 1))) = 0;
END_RULE;
(*
```

Formal propositions:

WR1: For each **versioned_action_request** there shall be exactly one **action_request_status** that has the **versioned_action_request** as its **assigned_request**.

5.2.4.9 dependent_instantiable_application_context

The **dependent_instantiable_application_context** rule specifies that all instances of **application_-context** are dependent on their usage to define another entity.

EXPRESS specification:

```
*)
RULE dependent_instantiable_application_context FOR (application_context);
```

```
WHERE
  WR1: SIZEOF (QUERY (ac <* application_context |
       NOT (SIZEOF (USEDIN (ac, '')) >= 1))) = 0;
END_RULE;
(*
```

Argument definition:

application_context: the set of all instances of the **application_context** entity data type.

Formal proposition:

WR1: For each instance of **application_context**, there shall be a reference to the **application_context** instance from an attribute of another entity.

5.2.4.10 dependent_instantiable_product_context

The **dependent_instantiable_product_context** rule specifies that all instances of **product_context** are dependent on their usage to define another entity.

EXPRESS specification:

```
*)
RULE dependent_instantiable_product_context FOR (product_context);
WHERE
  WR1: SIZEOF (QUERY (pc <* product_context |
       NOT (SIZEOF (USEDIN (pc, '')) >= 1))) = 0;
END_RULE;
(*
```

Argument definition:

product_context: the set of all instances of the **product_context** entity data type.

Formal proposition:

WR1: For each instance of **product_context**, there shall be a reference to the **product_context** instance from an attribute of another entity.

5.2.4.11 dependent_instantiable_product_definition_context

The **dependent_instantiable_product_definition_context** rule specifies that all instances of **product_-definition_context** are dependent on their usage to define another entity.

EXPRESS specification:

```
*)
RULE dependent_instantiable_product_definition_context FOR
  (product_definition_context);
WHERE
  WR1: SIZEOF (QUERY (pdc <* product_definition_context |
       NOT (SIZEOF (USEDIN (pdc, '')) >= 1))) = 0;
END_RULE;
(*
```

Argument definition:

product_definition_context: the set of all instances of the **product_definition_context** entity data type.

Formal proposition:

WR1: For each instance of **product_definition_context**, there shall be a reference to the **product_-definition_context** instance from an attribute of another entity.

5.2.4.12 product_context_discipline_type_constraint

Every **product_context** shall have a **discipline_type** of ‘process plant’.

EXPRESS specification:

```
*)
RULE product_context_discipline_type_constraint FOR
  (product_context);
WHERE
  WR1: SIZEOF (QUERY (pc <* product_context |
       NOT (pc.discipline_type = 'process plant'))) = 0;
END_RULE;
(*
```

Formal propositions:

WR1: For each **product_context**, the **name** shall be ‘process plant’.

5.2.4.13 product_definition_context_name_constraint

Every **product_definition_context** shall have a name of ‘functional definition’, ‘physical definition’, ‘functional occurrence’, ‘physical occurrence’, ‘catalogue definition’, or ‘fabrication assembly’.

EXPRESS specification:

```
*)
RULE product_definition_context_name_constraint FOR
  (product_definition_context);
WHERE
  WR1: SIZEOF (QUERY (pdc <* product_definition_context |
       NOT (pdc.name IN
       ['functional definition', 'physical definition',
        'functional occurrence', 'physical occurrence',
        'catalogue definition', 'fabrication assembly']))) = 0;
END_RULE;
(*
```

Formal propositions:

WR1: For each **product_definition_context**, the **name** shall be ‘functional definition’, ‘physical definition’, ‘functional occurrence’, ‘physical occurrence’, ‘catalogue definition’, or ‘fabrication assembly’.

5.2.4.14 product_definition_usage_constraint

Every **product_definition** that identifies an item that may be used as a component of a plant shall have restricted participation in relationships with other **product_definition**s.

EXPRESS specification:

```
*)
RULE product_definition_usage_constraint FOR (product_definition);
WHERE
  WR1: SIZEOF (QUERY (pd <* product_definition |
       ((pd.frame_of_reference.name = 'physical occurrence') AND
       (NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
       'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_RELATIONSHIP.' +
       'RELATED_PRODUCT_DEFINITION') |
       SIZEOF (TYPEOF (pdr) *
       ['PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_USAGE',
       'PLANT_SPATIAL_CONFIGURATION.MAKE_FROM_USAGE_OPTION',
       'PLANT_SPATIAL_CONFIGURATION.ASSEMBLY_COMPONENT_USAGE'])
       = 1)) <= 1))))) = 0;
END_RULE;
(*
```

Formal propositions:

WR1: For each **product_definition** that has a **product_definition_context** where the name is ‘physical occurrence’, the **product_definition** shall be the **related product_definition** in at most one **product_definition_usage**, **make_from_usage_option**, or **assembly_component_usage**.

5.2.4.15 subtype_exclusive_characterized_object

All instances of **characterized_object** shall be an instance of at most one of **piping_component_class**, **site**, **stream_design_case**, or **inspection_condition**.

EXPRESS specification:

```
*)
RULE subtype_exclusive_characterized_object FOR
  (characterized_object);
WHERE
  WR1: SIZEOF (QUERY (co <*characterized_object |
       NOT (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_CLASS',
       'PLANT_SPATIAL_CONFIGURATION.SITE',
       'PLANT_SPATIAL_CONFIGURATION.STREAM_DESIGN_CASE']
       * TYPEOF (co)) <= 1))) = 0;
END_RULE;
(*
```

Formal propositions:

WR1: Every instance of **characterized_object** shall also be an instance of at most one of **piping_component_class**, **site**, or **stream_design_case**.

5.2.4.16 subtype_mandatory_externally_defined_item

All instances of **externally_defined_item** shall either be be instances of **known_source** or of **externally_defined_document**.

EXPRESS specification:

```
*)
RULE subtype_mandatory_externally_defined_item FOR
  (externally_defined_item);
WHERE
  WR1: SIZEOF (QUERY (edi <* externally_defined_item |
       NOT (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.CATALOGUE_CONNECTOR',
```

```
       'PLANT_SPATIAL_CONFIGURATION.EXTERNALLY_DEFINED_CLASS',
       'PLANT_SPATIAL_CONFIGURATION.EXTERNALLY_DEFINED_PLANT_ITEM_DEFINITION',
       'PLANT_SPATIAL_CONFIGURATION.EXTERNALLY_DEFINED_DOCUMENT']
       * TYPEOF (edi)) = 1))) = 0;
END_RULE;
(*
```

Formal propositions:

WR1: Every instance of **externally_defined_item** shall also be an instance of one of **catalogue_-connector**, **externally_defined_classification**, **externally_defined_plant_item_definition**, or **externally_defined_document**.

5.2.4.17 subtype_mandatory_pre_defined_item

All instances of **pre_defined_item** shall be instances of **known_source**.

EXPRESS specification:

```
*)
RULE subtype_mandatory_pre_defined_item FOR
  (pre_defined_item);
WHERE
  WR1: SIZEOF (QUERY (pdi <* pre_defined_item |
       NOT ('PLANT_SPATIAL_CONFIGURATION.KNOWN_SOURCE' IN
       TYPEOF (pdi)))) = 0;
END_RULE;
(*
```

Formal propositions:

WR1: Every instance of **pre_defined_item** shall also be an instance of **known_source**.

5.2.4.18 subtype_mandatory_shape_representation

All instances of **shape_representation** shall be instances of exactly one of **hybrid_shape_-representation**, **plant_csg_shape_representation**, **shape_dimension_representation**, **site_-representation**, or **plant_design_csg_primitive**.

EXPRESS specification:

```
*)
RULE subtype_mandatory_shape_representation FOR
  (shape_representation);
WHERE
  WR1: SIZEOF (QUERY (sr <* shape_representation |
       NOT (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.' +
       'PLANT_CSG_SHAPE_REPRESENTATION',
       'PLANT_SPATIAL_CONFIGURATION.HYBRID_SHAPE_REPRESENTATION',
       'PLANT_SPATIAL_CONFIGURATION.SHAPE_DIMENSION_REPRESENTATION',
       'PLANT_SPATIAL_CONFIGURATION.' +
       'SITE_REPRESENTATION',
       'PLANT_SPATIAL_CONFIGURATION.PLANT_DESIGN_CSG_PRIMITIVE']
       * TYPEOF (sr)) = 1))) = 0;
END_RULE;
(*
```

Formal propositions:

WR1: Every instance of **shape_representation** shall be an instance of exactly one of **plant_csg_shape_-**

representation, **hybrid_shape_representation**, **shape_dimension_representation**, **site_-representation**, or plant_design_csg_primitive.

5.2.4.19 value_for_application_context

The application attribute of **application_context** shall have a value of ‘plant spatial configuration’.

EXPRESS specification:

```
*)
RULE value_for_application_context FOR
  (application_context);
WHERE
  WR1: SIZEOF (QUERY (ac <* application_context |
       NOT (ac.application = 'plant spatial configuration'))) = 0;
END_RULE;
(*
```

Formal propositions:

WR1: Every **application_context** shall have an application attribute with a value of ‘plant spatial configuration’.

5.2.4.20 version2_p41_object_role_selection

Every **role_association** instance shall associate a role with only a **plant_spatial_configuration_-change_assignment**.

EXPRESS specification:

```
*)
RULE version2_p41_object_role_selection FOR
  (role_association);
WHERE
  WR1: SIZEOF (QUERY (ra <* role_association |
       NOT ('PLANT_SPATIAL_CONFIGURATION.' +
       'PLANT_SPATIAL_CONFIGURATION_CHANGE_ASSIGNMENT' IN
       TYPEOF (ra.item_with_role)))) = 0;
END_RULE;
(*
```

Formal propositions:

WR1: Each **role_association** shall reference only instances of **plant_spatial_configuration_change_-assignment** as its **item_with_role**.

5.2.4.21 version2_p41_uninstantiable_basic_attributes

There shall be no instances of **description_attribute**, **id_attribute**, or **name_attribute** populated according to this part of ISO 10303.

EXPRESS specification:

```
*)
RULE version2_p41_uninstantiable_basic_attributes FOR
  (description_attribute, id_attribute, name_attribute);
WHERE
  WR1: SIZEOF (bag_to_set (description_attribute)) = 0;
      WR2: SIZEOF (bag_to_set (id_attribute)) = 0;
```

```
  WR3: SIZEOF (bag_to_set (name_attribute)) = 0;
END_RULE;
(*
```

Formal propositions:

WR1: There shall be zero instances of **description_attribute**.

WR2: There shall be zero instances of **id_attribute**.

WR3: There shall be zero instances of **name_attribute**.

5.2.5 Plant spatial configuration function definitions

5.2.5.1 applied_identification_correlation

The **applied_organization_correlation** boolean function returns TRUE if the **name** attribute of the **identification_role** entity is coordinated with the type of entity selected in the **items** of an **applied_-organization_assignment**.

EXPRESS specification:

```
*)
FUNCTION applied_identification_correlation
  (aia : applied_identification_assignment ) : BOOLEAN;
  LOCAL
    i_role : STRING;
  END_LOCAL;
    i_role := aia\identification_assignment.role.name;
  CASE i_role OF
    'global unambiguous identifier' :
                          IF SIZEOF (aia.items) <>
                          SIZEOF (QUERY (x <* aia.items |
                          'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION'
                          IN TYPEOF (x)))
                          THEN RETURN(FALSE);
                          END_IF;
    'stock code'        : IF SIZEOF (aia.items) <>
                          SIZEOF (QUERY (x <* aia.items |
                          'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION'
                          IN TYPEOF (x)))
                          THEN RETURN(FALSE);
                          END_IF;
    'weld id'           : IF SIZEOF (aia.items) <>
                          SIZEOF (QUERY (x <* aia.items |
                          'PLANT_SPATIAL_CONFIGURATION.MATERIAL_PROPERTY'
                          IN TYPEOF (x)))
                          THEN RETURN(FALSE);
                          END_IF;
    'connecting portion id'
                        : IF SIZEOF (aia.items) <>
                          SIZEOF (QUERY (x <* aia.items |
                          'PLANT_SPATIAL_CONFIGURATION.MATERIAL_PROPERTY'
                          IN TYPEOF (x)))
                          THEN RETURN(FALSE);
                          END_IF;
    'analysis data point id'
                        : IF SIZEOF (aia.items) <>
                          SIZEOF (QUERY (x <* aia.items |
                          'PLANT_SPATIAL_CONFIGURATION.SHAPE_ASPECT'
                          IN TYPEOF (x)))
                          THEN RETURN(FALSE);
                          END_IF;
    'document version id'
```

```
                        : IF SIZEOF (aia.items) <>
                          SIZEOF (QUERY (x <* aia.items |
                          'PLANT_SPATIAL_CONFIGURATION.DOCUMENT'
                          IN TYPEOF (x)))
                          THEN RETURN(FALSE);
                          END_IF;
    OTHERWISE : RETURN(TRUE);
  END_CASE;
  RETURN (TRUE);
END_FUNCTION;
(*
```

Argument definitions:

aia: the input **applied_identification_assignment** to be checked.

5.2.5.2 bag_to_set

The **bag_to_set** function converts BAGs into SETs.

EXAMPLE It can be used to convert the BAGs returned by the USEDIN function into SETs that can be properly assigned to variables that are SETs.

EXPRESS specification:

```
*)
FUNCTION bag_to_set (the_bag: BAG OF GENERIC:intype) :
    SET OF GENERIC:intype;
  LOCAL
    the_set : SET OF GENERIC:intype := [];
    i       : INTEGER;
  END_LOCAL;
  IF SIZEOF(the_bag) > 0 THEN
    REPEAT i := 1 TO HIINDEX(the_bag) BY 1;
      the_set := the_set + the_bag[i];
    END_REPEAT;
  END_IF;
  RETURN(the_set);
END_FUNCTION;
(*
```

Argument definitions:

the_bag: the BAG that is to be converted into a SET.

5.2.5.3 class_in_tree

The **class_in_tree** function is a boolean function that returns true if the specified **group** has the **name** specified by the **val** parameter, or if the specified **group** has a parent in a tree of related **group**s with the **name** specified by the **val** parameter.

EXPRESS specification:

```
*)
FUNCTION class_in_tree (class : group; val : STRING) : BOOLEAN;
  IF class.name = val THEN RETURN (TRUE);
  ELSE
    RETURN (SIZEOF (QUERY (gr <* USEDIN (class,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'GROUP_RELATIONSHIP.RELATED_GROUP') |
    class_in_tree (gr.relating_group, val))) = 1);
      END_IF;
```

```
  RETURN (FALSE);
END_FUNCTION;
(*
```

Argument definitions:

class: the **group** containing the **name** for which the specified value is required.

val: the **value** that is required for the name of the **group**.

5.2.5.4 plant_spatial_configuration_organization_correlation

The **plant_spatial_configuration_organization_correlation** boolean function returns TRUE if the **name** attribute of the **organization_role** entity is coordinated with the type of entity selected in the **items** of a **plant_spatial_configuration_organization_assignment**.

EXAMPLE If the role for an **organization** is 'vendor', then all of the **items** in the set must be either **product** or **document**.

EXPRESS specification:

```
*)
FUNCTION plant_spatial_configuration_organization_correlation
  (e : plant_spatial_configuration_organization_assignment ) : BOOLEAN;
  LOCAL
    o_role : STRING;
  END_LOCAL;
    o_role := e\organization_assignment.role.name;
  CASE o_role OF
    'vendor'            : IF SIZEOF (e.items) <>
                          SIZEOF (QUERY (x <* e.items |
                          SIZEOF(['PLANT_SPATIAL_CONFIGURATION.PRODUCT',
                                  'PLANT_SPATIAL_CONFIGURATION.DOCUMENT'] *
                          TYPEOF (x)) = 1))
                          THEN RETURN(FALSE);
                          END_IF;
    'owner'             : IF SIZEOF (e.items) <>
                          SIZEOF (QUERY (x <* e.items |
                          SIZEOF(['PLANT_SPATIAL_CONFIGURATION.SITE',
                                  'PLANT_SPATIAL_CONFIGURATION.DOCUMENT'] *
                          TYPEOF (x)) = 1))
                          THEN RETURN(FALSE);
                          END_IF;
    'plant operator'    : IF SIZEOF (e.items) <>
                          SIZEOF (QUERY (x <* e.items |
                          'PLANT_SPATIAL_CONFIGURATION.PLANT'
                          IN TYPEOF (x)))
                          THEN RETURN(FALSE);
                          END_IF;
    'plant owner'       : IF SIZEOF (e.items) <>
                          SIZEOF (QUERY (x <* e.items |
                          'PLANT_SPATIAL_CONFIGURATION.PLANT'
                          IN TYPEOF (x)))
                          THEN RETURN(FALSE);
                          END_IF;
    'project owner'     : IF SIZEOF (e.items) <>
                          SIZEOF (QUERY (x <* e.items |
                          'PLANT_SPATIAL_CONFIGURATION.DESIGN_PROJECT'
                          IN TYPEOF (x)))
                          THEN RETURN(FALSE);
                          END_IF;
    'assessor'          : IF SIZEOF (e.items) <>
                          SIZEOF (QUERY (x <* e.items |
                          'PLANT_SPATIAL_CONFIGURATION.' +
                          'PRODUCT_DEFINITION_RELATIONSHIP'
```

```
                          IN TYPEOF (x)))
                          THEN RETURN(FALSE);
                          END_IF;
    OTHERWISE : RETURN(TRUE);
  END_CASE;
  RETURN (TRUE);
END_FUNCTION;
(*
```

Argument definitions:

e: the input **plant_spatial_configuration_organization_assignment** to be checked.

5.2.5.5 plant_spatial_configuration_person_and_organization_correlation

The **plant_spatial_configuration_person_and_organization_correlation** boolean function returns TRUE if the **name** attribute of the **person_organization_role** entity is coordinated with the type of entity selected in the **items** of a **plant_spatial_configuration_person_and_organization_assignment**.

EXAMPLE If the role for a **person_and_organization** is 'owner', then all of the **items** in the set must be either **site** or **change_item**.

EXPRESS specification:

```
*)
FUNCTION plant_spatial_configuration_person_and_organization_correlation
  (e : plant_spatial_configuration_person_and_organization_assignment )
  : BOOLEAN;
  LOCAL
    po_role : STRING;
  END_LOCAL;
    po_role := e\person_and_organization_assignment.role.name;
  CASE po_role OF
    'owner'             : IF SIZEOF (e.items) <>
                          SIZEOF (QUERY (x <* e.items |
                          SIZEOF(['PLANT_SPATIAL_CONFIGURATION.SITE',
                                  'PLANT_SPATIAL_CONFIGURATION.' +
                                  'CHANGE_ITEM'] *
                          TYPEOF (x)) = 1))
                          THEN RETURN(FALSE);
                          END_IF;
    'plant owner'       : IF SIZEOF (e.items) <>
                          SIZEOF (QUERY (x <* e.items |
                          'PLANT_SPATIAL_CONFIGURATION.PLANT'
                          IN TYPEOF (x)))
                          THEN RETURN(FALSE);
                          END_IF;
    'plant operator'    : IF SIZEOF (e.items) <>
                          SIZEOF (QUERY (x <* e.items |
                          'PLANT_SPATIAL_CONFIGURATION.PLANT'
                          IN TYPEOF (x)))
                          THEN RETURN(FALSE);
                          END_IF;
    OTHERWISE : RETURN(TRUE);
  END_CASE;
  RETURN (TRUE);
END_FUNCTION;
(*
```

Argument definitions:

e: the input **plant_spatial_configuration_person_and_organization_assignment** to be checked.

5.2.5.6 plant_spatial_configuration_person_correlation

The **plant_spatial_configuration_person_correlation** boolean function returns TRUE if the **name** attribute of the **person_role** entity is coordinated with the type of entity selected in the **items** of a **plant_spatial_configuration_person_assignment**.

EXAMPLE If the role for a **person** is 'owner', then all of the **items** in the set must be either **site** or **document**.

EXPRESS specification:

```
*)
FUNCTION plant_spatial_configuration_person_correlation
  (e : plant_spatial_configuration_person_assignment ) : BOOLEAN;
  LOCAL
    p_role : STRING;
  END_LOCAL;
    p_role := e\person_assignment.role.name;
  CASE p_role OF
    'vendor'            : IF SIZEOF (e.items) <>
                          SIZEOF (QUERY (x <* e.items |
                          'PLANT_SPATIAL_CONFIGURATION.DOCUMENT'
                          IN TYPEOF (x)))
                          THEN RETURN(FALSE);
                          END_IF;
    'owner'             : IF SIZEOF (e.items) <>
                          SIZEOF (QUERY (x <* e.items |
                          SIZEOF(['PLANT_SPATIAL_CONFIGURATION.SITE',
                                  'PLANT_SPATIAL_CONFIGURATION.DOCUMENT'] *
                          TYPEOF (x)) = 1))
                          THEN RETURN(FALSE);
                          END_IF;
    'plant owner'       : IF SIZEOF (e.items) <>
                          SIZEOF (QUERY (x <* e.items |
                          'PLANT_SPATIAL_CONFIGURATION.PLANT'
                          IN TYPEOF (x)))
                          THEN RETURN(FALSE);
                          END_IF;
    'assessor'          : IF SIZEOF (e.items) <>
                          SIZEOF (QUERY (x <* e.items |
                          'PLANT_SPATIAL_CONFIGURATION.' +
                          'PRODUCT_DEFINITION_RELATIONSHIP'
                          IN TYPEOF (x)))
                          THEN RETURN(FALSE);
                          END_IF;
    OTHERWISE : RETURN(TRUE);
  END_CASE;
  RETURN (TRUE);
END_FUNCTION;
(*
```

Argument definitions:

e: the input **plant_spatial_configuration_person_assignment** to be checked.

5.2.5.7 valid_advanced_csg_tree

The **valid_advanced_csg_tree** function returns true if the elements that comprise the CSG tree passed in as a parameter satisfy the requirements defined for advanced CSG trees.

EXPRESS specification:

```
*)
FUNCTION valid_advanced_csg_tree (tree_element : boolean_operand) : BOOLEAN;
  -- return true if the tree_element is a valid primitive
```

```
  IF SIZEOF (TYPEOF (tree_element) *
    ['PLANT_SPATIAL_CONFIGURATION.BLOCK',
    'PLANT_SPATIAL_CONFIGURATION.TORUS',
    'PLANT_SPATIAL_CONFIGURATION.RIGHT_CIRCULAR_CYLINDER',
    'PLANT_SPATIAL_CONFIGURATION.SPHERE',
    'PLANT_SPATIAL_CONFIGURATION.RIGHT_CIRCULAR_CONE',
    'PLANT_SPATIAL_CONFIGURATION.ECCENTRIC_CONE',
    'PLANT_SPATIAL_CONFIGURATION.PLANT_DESIGN_CSG_PRIMITIVE',
    'PLANT_SPATIAL_CONFIGURATION.CYCLIDE_SEGMENT_SOLID',
    'PLANT_SPATIAL_CONFIGURATION.RECTANGULAR_PYRAMID',
    'PLANT_SPATIAL_CONFIGURATION.EXTRUDED_AREA_SOLID',
    'PLANT_SPATIAL_CONFIGURATION.REVOLVED_AREA_SOLID',
    'PLANT_SPATIAL_CONFIGURATION.HALF_SPACE_SOLID']) = 1
    THEN RETURN (TRUE);
    ELSE
    -- if the tree_element is a boolean_result check its operations and
    -- operands
    IF 'PLANT_SPATIAL_CONFIGURATION.BOOLEAN_RESULT'
    IN TYPEOF (tree_element)
      THEN
      -- addition and subtraction are the only valid operations
      IF NOT (tree_element\boolean_result.operator
        IN [boolean_operator.union, boolean_operator.difference])
        THEN RETURN (FALSE);
      END_IF;
      -- if the operand is a half_space_solid, check for advanced surface
      -- otherwise return false and recursively check second operand
      IF 'PLANT_SPATIAL_CONFIGURATION.HALF_SPACE_SOLID' IN
        TYPEOF (tree_element\boolean_result.first_operand) THEN
        IF 'PLANT_SPATIAL_CONFIGURATION.ELEMENTARY_SURFACE' IN
          TYPEOF (tree_element\boolean_result.
                  first_operand\half_space_solid.base_surface) THEN
          IF 'PLANT_SPATIAL_CONFIGURATION.HALF_SPACE_SOLID' IN
            TYPEOF (tree_element\boolean_result.second_operand) THEN
            IF 'PLANT_SPATIAL_CONFIGURATION.ELEMENTARY_SURFACE' IN
              TYPEOF (tree_element\boolean_result.
                      second_operand\half_space_solid.base_surface) THEN
              RETURN (TRUE);
              ELSE RETURN (FALSE);
            END_IF;
            ELSE RETURN (valid_advanced_csg_tree
            (tree_element\boolean_result.second_operand));
          END_IF;
          ELSE RETURN (FALSE);
        END_IF;
        ELSE
          IF 'PLANT_SPATIAL_CONFIGURATION.HALF_SPACE_SOLID' IN
            TYPEOF (tree_element\boolean_result.second_operand) THEN
            IF 'PLANT_SPATIAL_CONFIGURATION.ELEMENTARY_SURFACE' IN TYPEOF
              (tree_element\boolean_result.second_operand\half_space_solid.
               base_surface) THEN
              RETURN (valid_advanced_csg_tree
                        (tree_element\boolean_result.first_operand));
              ELSE
              RETURN (FALSE);
            END_IF;
            ELSE
            RETURN (valid_advanced_csg_tree
                      (tree_element\boolean_result.first_operand) AND
                    valid_advanced_csg_tree
                      (tree_element\boolean_result.second_operand));
          END_IF;
      END_IF;
    END_IF;
  END_IF;
  RETURN (FALSE);
END_FUNCTION;
(*
```

Argument definitions:

tree_element: (input) the **boolean_operand** to be evaluated.

```
*)
END_SCHEMA;
(*
```